NATURE

No. 4318 SATURDAY, AUGUST 2, 1952 Vol. 170

CONTENTS

	Page
State Expenditure on Universities in Great Britain	171
Moral Philosophy and Social Anthropology. By The Right Hon. Lord Raglan	174
Smithsonian Meteorological Tables. By G. A. Bull	175
Hydrogenation of Oils and Fats. By Dr. H. Jasperson	175
Mineral Nutrition of Plants. By Dr. G. Bond	176
Psychical Research Dissected. By Dr. E. J. Dingwall	176
Biology of Human Starvation. By Dr. E. M. Widdowson	177
National Physical Laboratory, Teddington: Open Day	179
Virus Diseases of Fruit Crops. By Dr. A. F. Posnette and Dr. R. V. Harris	181
Education and Training of Metallurgists. By Prof. F. C. Thompson	182
Obituaries:	
Sir Lindsay Scott, K.C.B. By Prof. Stuart Piggott	184
Mr. F. W. H. Migeod. By Dr. W. E. Swinton	184
Prof. Tadeusz Estreicher. By Prof. John Read, F.R.S.	184
News and Views	185
Biological Activity of Complex Ions. By Dr. F. P. Dwyer, Dr. Eleonora C. Gyarfas, Dr. W. P. Rogers and Dr. Judith H. Koch	190
Radio Observations of the Solar Eclipses of September 1, 1951, and February 25, 1952. By J.-F. Denisse, E. J. Blum and J.-L. Steinberg	191
Measurement and Interpretation of Eye-dominance. By Margaret M. Clark	192
Radiation Chemistry. By Dr. J. W. Belton	194
Scientific Education of Physicists	196
Posterior Pituitary Gland: Symposium at Cambridge	197
Long Ashton Research Station: Report for 1950	198
Letters to the Editors:	
Heat Flow through the Floor of the Eastern North Pacific Ocean.—Roger Revelle and Arthur E. Maxwell; Dr. E. C. Bullard, F.R.S.	199
Use of a Gamma-Ray Pinhole Camera for *in vivo* Studies.—H. O. Anger	200
Microradiography with Alpha-Rays.—Gunnar Aniansson and Naftali Steiger	201
Diffraction Microscopy with X-Rays.—M. E. Haine and T. Mulvey	202
Surface Oxide Films in Intermetallic Contacts.—M. Cocks	203
Contrasting Methods of Transmission of Animal Viruses by Mosquitoes.—Prof. Frank Fenner and Dr. M. F. Day	204
Non-random Distribution of Multiple Mitotic Crossing-over among Nuclei of Heterozygous Diploid *Aspergillus*.—Dr. G. Pontecorvo	204
Excitation of Ganglion Cells in the Inferior Mesenteric Ganglion by Collaterals.—C. Job and Dr. A. Lundberg	205
Senility Changes in the Spinal Ganglion Neurones of the Toad, *Bufo regularis*.—Dr. Tohamy A. Moussa	206
Giant Nerve Cells in *Lissula*.—P. Kirtisinghe	206
Lactic Oxidases of *Mycobacterium tuberculosis avium*.—Yuichi Yamamura, Masamiti Kusunose and Emi Kusunose	207
Growth of Rat Ovary in Tissue Culture.—Jean I. Scott	208
Development of the Embryonic Coverings in the Scorpion, *Buthus quinquestriatus* (H.E.).—Dr. A. Abdel-Wahab	209
Seasonal Change in the Humidity Reaction of the Common Earwig, *Forficula auricularia*.—Dr. Vilho Perttunen	209
Maximum Molecular Weight of Insulin.—Dr. J. M. Creeth	210
A Synergistic Interaction between 3-Indolylacetonitrile and 3-Indolylacetic Acid.—Daphne J. Osborne	210
Hydrogen Transfer by Thiols.—Dr. A. F. Bickel and Dr. E. C. Kooijman	211
Thiol Catalysis of the Homolytic Decomposition of Aldehydes.—E. F. P. Harris and Dr. W. A. Waters	212
Mechanism of the Reaction between Dichromate and Diphenylcarbazide.—Monisha Bose	213

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone Number: Temple Bar 1942

All rights reserved. Registered as a newspaper at the General Post Office

STATE EXPENDITURE ON UNIVERSITIES IN GREAT BRITAIN

THE grant in aid of the universities and colleges in Great Britain, which in the Civil Estimates of 1951–52 amounts to more than £23 million, and which, according to the Chancellor's statement on February 21, is to rise to £25 millions in 1956–57, apart altogether from non-recurrent grants, is by far the largest of the grants in aid of services at home of which detailed accounts are not available to the Comptroller and Auditor-General. No other grant exceeds £200,000, and most of them are less than £20,000. Moreover, any balance issued but not spent by the end of the financial year is not liable to be returned to the Exchequer.

It is generally recognized that certain non-Governmental bodies which derive the main part of their finances should yet, in the public interest, be allowed to retain the maximum degree of independence. Chancellors of the Exchequer and the Treasury itself, no less than the University Grants Committee, have repeatedly emphasized the desirability of preserving the autonomy of the Universities. Nevertheless, the Committee of Public Accounts for 1948–49 expressed the wish to see more effective means of securing adequate Parliamentary control over this large expenditure of public money. Particularly in view of the steep increase in this expenditure in post-war years, it pressed the Treasury to consider whether, without impairing the independence of the universities, any further means could be adopted of informing Parliament more precisely how the grant in aid proposed in the estimate is to be spent and assuring Parliament that grants to the universities are wisely used. The Treasury agreed with this view, and, in a subsequent report from the Committee for the session 1950, it was stated that before arrangements were settled for the next quinquennium, the Treasury would make a very close review in conjunction with the University Grants Committee of what had been achieved. Eventually the Committee of Public Accounts for the session 1950–51 recommended that the books and accounts of bodies which receive the greater part of their income from public funds should normally be open to inspection by the Comptroller and Auditor-General, and this recommendation was welcomed by the Treasury in a Minute dated November 29, 1951.

For reasons which are well explained by Dr. Basil Chubb in his recent book "The Control of Public Expenditure"*, this was as far as the Committee of Public Accounts could pursue the matter. The Select Committee on Estimates, however, is not limited to the examination of the estimates or accounts but is able to pass in review the organization concerned. Its Fifth Report for the session 1951–52† records an examination not so much of university finance as of

* The Control of Public Expenditure: Financial Committees of the House of Commons. By Basil Chubb. Pp. viii+292. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 25*s*. net.

† Fifth Report from the Select Committee on Estimates, Session 1951–52: The Grant in aid of Universities and Colleges. Pp. 70. (London: H.M.S.O., 1952.) 4*s*. net.

the functioning of the University Grants Committee and the control it exercises over the expenditure of Treasury grants. The inquiry has been prompted by the considerations already indicated, and it can be said that the University Grants Committee emerges with credit from the scrutiny and that its continued existence is regarded as providing the best solution to the problem of maintaining control.

As this report shows, Treasury grants have now risen from about one-third of university income before the War to two-thirds, and it will be recalled that in a "Note on University Policy and Finance in the Decennium 1947–56" issued in August 1946, the Committee of Vice-Chancellors and Principals concluded that during this decade the pre-war combined annual revenue of the universities would need to be multiplied threefold, and that of this total revenue about three-quarters would have to come from Government sources by way of the University Grants Committee. No fears appear then to have been entertained on the side of the Universities that, with the device of the University Grants Committee, such increased financial reliance on the State need impair their academic independence. On the contrary, this Note stated explicitly: "The Universities entirely accept the view that the Government has not only the right but the duty to satisfy itself that every field of study which in the national interest ought to be cultivated in Great Britain is in fact being adequately cultivated in the University system and that the resources which are placed at the disposal of the Universities are being used with full regard both to efficiency and to economy".

There has in the meantime been no indication of dissent from the view then expressed by the vice-chancellors that the universities may properly be expected not only individually to make proper use of the resources entrusted to them, but also collectively to devise and execute policies calculated to serve the national interest. Both individually and collectively they appear so far to have welcomed an increasing measure of guidance from Government. The main question is as to the form in which that guidance and supervision should be exercised; this question is at the root of the report from the Select Committee on Estimates. Its examination of the functioning of the University Grants Committee is, moreover, of wider interest at the present time, first because of the way in which certain matters such as the expansion of higher technological education affect other bodies besides the universities, with which the University Grants Committee have not even advisory relations, and secondly because of a disposition to suggest the application of a like device in other fields in which State assistance is given.

The University Grants Committee was appointed in 1919: "To inquire into the financial needs of University Education in the United Kingdom, and to advise the Government as to the application of any grants that may be made by Parliament towards meeting them". Although the Committee was merely expected to advise the Treasury on the application of public money granted to the universities of Britain, in practice it has since become also an executive body. The Treasury has left it to the Committee to allocate the money among the universities and to do all the office work in connexion with this allocation and with the extensive building programme which has proceeded since 1947. This position was officially recognized by the Government in July 1946, when the terms of reference of the Committee were revised to correspond with the responsibilities which the Committee was actually discharging. A secondary effect was a substantial reduction of the average age of the members of the Committee by the inclusion of people still engaged in academic work; the Committee now consists of sixteen members, assisted by a staff of twenty-four, and various specialist sub-committees.

Except in one respect, the Select Committee on Estimates makes no criticism of the personnel aspect of the University Grants Committee. Nowhere in this report does it suggest, as was argued in a recent debate in the House of Lords, that the Committee or its staff is obviously overburdened. On the contrary, the Estimates Committee was much impressed by the University Grants Committee's close contact with the universities, the apparent mutual confidence which exists, largely as a result of the smooth interchange of ideas between the universities and the Committee by frequent informal contact, and the wide understanding of the subject which that Committee displayed. Witnesses were unanimous in their assurances that consultations always ended in agreement, and that there was no question of the Committee forcing ideas upon unwilling universities.

The Estimates Committee recognizes in this report the practical efficacy of these frequent and informal meetings which form the basis of the work of the University Grants Committee; but it also gained the impression that much could also depend upon particular personalities, and especially the chairman and the secretary. It comments pointedly on the need for ensuring continuity in the senior full-time posts and particularly on the apparent absence of an arrangement for succession to the post of secretary, although the grade of the secretaryship has been purposely raised to compensate for the absence of a full-time deputy chairman. That consideration should be given to ensuring continuity in these senior full-time posts is one of the five definite recommendations.

It is in the interests of the Chancellor of the Exchequer, the Treasury and the University Grants Committee, on one side, and of the universities, on the other (especially in view of their increased dependence on public money and the absence of direct Parliamentary control over its expenditure), that each university should recognize its responsibility to ensure that its affairs are managed with due economy and in the best interests of the nation; and given this no serious conflict should arise between the two sides because of the general desire to maintain the independence of the universities and the need for the exercise of proper financial control both by the University Grants Committee and by Parliament. That Committee exercises its control in three main ways: through supervision of quin-

quennial staff requirements, through the receipt of annual returns of staff, students and expenditure, and through the continuous process of unofficial audit by personal contact with the heads and various governing bodies. The last is regarded as the most effective and is manifestly the reason why the Estimates Committee considers the continued existence of the University Grants Committee as providing the best solution to the problem of maintaining control.

The effectiveness of the University Grants Committee lies largely in the fact that the universities are probably best understood by a body consisting mainly of university professors and persons eminent in the academic world acting on behalf of the Treasury. Such a Committee is in a position to suggest the most effective means of meeting new requirements, even if the need for central co-ordination may tend to diminish during a period of consolidation. The confidence entertained in such a body by the universities may be as important a factor as its financial influence in initiating changes and securing new developments; and no factor requires closer consideration than this by those who are considering the adoption of a similar device in other fields of public policy. For here, confidence is based on mutual understanding. Above all, the universities can express their requirements and views to the Committee without the time-consuming necessity of detailed explanations as is often the case where a finance committee is not *au fait* with the problems involved.

Nevertheless, the Estimates Committee does not suggest that the position be left entirely as it is. It recommends the insertion in the Estimates each year of a note reconciling the amount of quinquennial grant proposed for the academic year with the total figure of recurrent grant shown in the Estimates for the financial year. Further, the fullest possible information should be supplied to Parliament, preferably in the estimates, whenever changes in the amount of recurrent grants are made, either as a result of the quinquennial review or at other times, showing the reasons for any change and the basis on which it is calculated. It also recommends that the practice, by which the books and accounts of bodies which receive the greater part of their income from public funds are normally open to inspection by the Comptroller and Auditor-General, should be extended to cover all money advanced by way of non-recurrent grants to the universities for capital development.

The Estimates Committee does not consider that the extension of this practice would in any way encroach on the freedom of the universities, and it will be clear that, having regard to the obligation of the universities to accept the lowest tender, the existing arrangements offer strong safeguards against extravagance already. What seems to be required is not so much closer control as fuller explanation and interpretation of their plans to the ordinary citizen, whether members of Parliament or not, so that the bearing of those plans on the national welfare and particularly the implication of the demands made on the national economy can be clearly understood. This is essential in such matters as the expansion of higher technological education, the organization of scientific and technical research and the problem of earmarked grants for recurrent expenditure. On this last point, the system is regarded, and not only in academic circles, as a serious encroachment on academic freedom. It is strongly disliked in the universities, and in its last report the University Grants Committee, while recognizing that the device was a necessary condition of securing that the developments judged to be desirable in the national interest are rapidly effected, was opposed to its permanent adoption when a satisfactory level of development had been reached in any of the special fields. With this view the Estimates Committee appears to agree in essence. It suggests, however, that when an earmarked grant is discontinued in favour of provision for the recurrent expenditure in the block grant, close scrutiny of the amount involved is desirable and not a mere addition to block grant of the amount of the former earmarked grant. There are occasions, it suggests, when the universities themselves are not in a position to be the best judges of what studies most need to be developed in the national interest. When some important new development needs to be promoted, and the expenditure on this can be isolated from other expenditure, an earmarked grant may afford the best means for keeping Parliament in close touch with the progress of the development.

Concern has been expressed elsewhere that the development of economic and social research in some universities might be impeded if the newer social science departments had to compete for their share of a block grant with the established departments in natural science, for example, instead of continuing to receive the earmarked grant. To that extent, support can be found for the view of the Estimates Committee. In general, however, this report affords no real evidence that the same result in regard to new developments could not be achieved by voluntary agreement or arrangement with the universities. On all that is said in this report it is difficult to imagine the universities refusing to accede to the expressed wishes of the University Grants Committee when based on reasoned argument and in the context of the mutual confidence and continuous informal exchange of views to which this report testifies.

The University Grants Committee thus emerges well from this scrutiny of the Select Committee on Estimates, as indeed it had earlier from that of the Committee of Public Accounts. There is no reason for supposing that the University Grants Committee will fail to take note of the broad hints given in this report as to the desirability of giving both Parliament and the public such further information as will assist in the formation of an intelligent appreciation of what the universities are doing, and a sound public judgment as to the place of the universities in the community and the return that is received from the expenditure of these large sums of public money. The report should dispose, too, of any suggestion that the Committee is over-burdened, or that it could not undertake fresh responsibilities, like that for the supervision of higher technological education.

MORAL PHILOSOPHY AND SOCIAL ANTHROPOLOGY

Experiments in Living

A Study of the Nature and Foundation of Ethics or Morals in the Light of Recent Work in Social Anthropology. By Prof. A. Macbeath. (The Gifford Lectures for 1948–1949 delivered in the University of St. Andrews.) Pp. xii+462. (London: Macmillan and Co., Ltd., 1952.) 30*s*. net.

PROF. A. MACBEATH has observed that most moralists and writers on ethics "simply ignore the moral judgments of other times and places, and the problems which the differences between the moral judgments of different peoples present for their theories", and realized that our own moral judgments as well as those of other peoples are the result of social conditioning. He is satisfied that there are no fundamental and innate differences between the primitive and the civilized mind, and he sets out to break down the 'iron curtain' between moral philosophy and social anthropology by studying the former in the light shed by the latter.

This purpose is a wholly admirable one, but unfortunately he starts by misstating his premises. He says: "The ways of life of different peoples I regard as experiments at giving concrete embodiment to the formal moral ideal. Each of them is the result of a co-operative effort to work out a way of living which will satisfy the main needs of man". He later qualifies this by saying that the experiments are largely blind; but it is a complete fallacy to suggest that they are experiments at all.

Consider our own code of morals. It is, of course, derived largely from what is known as Christian ethic; but that ethic contains many discrepancies. Let me give an example. In the Ancient East, in accordance with a system which has survived until recent times in Japan, Nepal and Fiji, the kingship was divided into two. There was the war king, whose duty it was to fight against demons, and their human representatives the foreigners, criminals and disturbers of the rites; and above him was the law king, who secured the prosperity of his people by the orderly performance of the rites, and who, since he stood for life, must not come into contact with death in any form. This dualism was taken over by Christianity, and as a result the Christian Church can embrace the soldier, the butcher and the hangman as well as those to whom these trades are abominable. There is a similar discrepancy, also due to ancient religious practices, between the ideals of chastity and of family life. We also have moral notions derived from other sources—the ideals of chivalry acquired by the Crusaders, Greek philosophy as interpreted by the schoolmen, and the Protestant speculations of the Geneva school. All these were foreign, and it was not until the end of the sixteenth century that Englishmen such as Bacon and Hooker began to have ideas of their own on the subject of morals. In spite, however, of more than three centuries of philosophy, there is very little in the moral code of Great Britain that can be supposed to have originated in this country or to have any special reference to the needs and desires of its people. When, therefore, the author quotes with approval the saying of Ross that our rules of conduct "embody the accumulated wisdom of our ancestors", he is propagating a fallacy.

The same applies to the so-called 'primitive' peoples. We know that they have not always lived in a state of isolation, but are where they are as the result of migrations, some of them quite recent. We know that they have all been in contact from time to time with higher cultures, and that there are few primitive areas in which archæologists do not dig up relics of cultures different from, and more advanced than, those now in being. It is true that primitive cultures are functioning wholes, but that is not because they are the result of successful experiments; it is because the odd pieces from various sources of which they are composed have been rubbed or worn down until they fit in together.

Prof. Macbeath supposes that the Australian Blacks have derived their totemic beliefs from their own experience. He might as well suppose that the peasants of Europe have derived their beliefs in the Lamb of God and the Holy Dove from their own experience. These beliefs are, of course, neither totemic nor primitive; but there can be little doubt that they as well as totemism spring from a system of animal symbolism which originated in Asia.

After ably summarizing accounts of the cultures of various primitive peoples, Prof. Macbeath discusses the alleged innate mental inferiority of primitives, and has no difficulty in showing that there is no evidence for such inferiority. In doing so, however, he and his authorities have missed the most important point. He quotes Prof. Lowie as saying that the Crow Indians are not given to systematic thinking. Of course they are not, for systematic thinking is possible only to people who can put their ideas into writing and then arrange them. Illiterates are mentally inferior simply because they are illiterate. It has been held against the African Negroes that they never produced a scientist; but what kind of a scientist would he be who had no weights and measures, no clock or calendar, and no means of recording his observations and experiments? And if it be asked why the Negroes did not invent these things, the answer is that neither did any European people, and for the same reason—namely, that the rare and perhaps unique conditions which made their invention possible were absent. Many learned men seem to fail to realize that if they had not been taught to read and write they would be at best rule-of-thumb craftsmen, the highest skill to which an illiterate can attain.

Prof. Macbeath then sets out to establish "that primitive morality is independent of religion in the sense that the moral ideals of primitive peoples do not derive their goodness, or their moral rules their rightness, from a religious source". Malinowski held that all morality is religious, and the author shows that Malinowski was wrong; but to jump, as Prof. Macbeath does, from the fact that some morality *is* secular to the conclusion that all morality *was* secular is quite illegitimate. He says that "there is a tendency for morality to acquire a religious sanction". This, namely that the secular readily becomes the sacred, is an assumption constantly made by theorists, but nobody has produced a scrap of evidence that it has ever happened; everything that is sacred now was sacred when first heard of. Let us take the example of dancing; if anyone were to maintain that all dancing is religious, it would be easy to show that he was wrong. But there is no doubt that much dancing is religious; and while there is no reason to believe that a secular dance has ever become sacred, there is good reason to believe that all dancing was originally religious. It is easy enough to forget the original purpose of a dance,

especially if it has never been written down, and just as easy to forget the origin of a moral rule, especially if it seems natural and obvious, as most of the allegedly secular rules do.

One could go on to show that the differences between civilized and primitive morals are not so great as Prof. Macbeath supposes, and that therefore his refutation of the intuitionist theory neither requires nor receives much support from anthropological data; but it is time to bring this review to a close by expressing regret that so able, accurate and lucid a writer has so often been led astray by those who, whatever their scientific reputation, are careful describers rather than logical thinkers.

RAGLAN

SMITHSONIAN METEOROLOGICAL TABLES

Smithsonian Meteorological Tables

Sixth revised edition, prepared by Robert J. List. (Smithsonian Miscellaneous Collections, Vol. 114: Publication 4014.) Pp. xi+527. (Washington, D.C.: Smithsonian Institution, 1951.) n.p.

THE sixth edition of the "Smithsonian Meteorological Tables" reflects the improvements in meteorological practice and the increase in accuracy of measurement of physical constants which have taken place since the publication of the fifth edition in 1931. The new edition contains 174 tables and an index in 527 pages, against 115 tables and index in the 282 pages in the fourth edition. The increase in the number of physical tables is actually greater than 59, because the tables of international codes and symbols used in transmitting and plotting meteorological observations and the list of observing stations have very reasonably been omitted from the new edition.

Since 1931 the advantages of representing the dynamic state of the upper atmosphere by plotting temperatures and heights for fixed pressures rather than the fields of temperature and pressure at fixed heights have been universally recognized, and tables for the construction and use of charts for fixed pressures appear in the new edition. The mass of water vapour in a kilogram of dry air, the humidity mixing ratio, has become for good reasons a much-used measure of atmospheric humidity, and a table, the first to be printed at sufficiently close intervals of pressure and temperature, is given for obtaining it. This table would perhaps have been more useful for British and American meteorologists if the temperature argument had been in Fahrenheit degrees instead of centigrade. Geopotential metres, in accordance with a resolution of the 1947 International Meteorological Organization Conference, replace geodynamic metres. Very detailed information, including a density altitude nomogram and tables of altimeter correction factors, are given for the American (N.A.C.A.) standard atmosphere; this is a little different from the standard used in Europe. It is, however, impossible to enumerate here more than a fraction of the new tables.

An improvement in arrangement is the placing of the explanation of each table immediately before it, instead of placing all the explanations at the beginning of the book. The new arrangement probably requires more space but will save much turning of pages. The explanations and references to sources are fuller and more critical than before. The compilers have decided, for reasons fully stated, to adhere to 980·665 cm. sec.$^{-2}$, adopted in 1892 by the International Commission for Weights and Measures, for the value of g at sea-level at latitude 45° in connecting the absolute unit of pressure with the length of the mercury column and not the more recently determined value 980·62. They naturally use the United States nautical mile, which is 0·2 ft. longer than the British one, with repercussions on the relation of the knot to other measures of velocity. The index is very full; an error noted in it is that the density of mercury is given for p. 3 instead of p. 4.

Meteorologists all over the world will be grateful to the Smithsonian Institution and the United States Weather Bureau, whose staff did most of the work, for producing this new edition of an indispensable work of reference.

G. A. BULL

HYDROGENATION OF OILS AND FATS

Hydrogenation of Fatty Oils

By Prof. H. I. Waterman, with the collaboration of C. Boelhouwer and L. J. Revallier. Pp. ix+254. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1951.) 42*s*.

THIS book, as the author states in his preface, is a review of developments in fatty oil hydrogenation in the light of investigations undertaken during recent years by the author and his collaborators at the Delft Technical University. Prof. H. I. Waterman has produced a stimulating book, which has been translated by Dr. S. Coffey in a competent manner.

As a whole, the book is concise and the subdivisions of chapters is clear and systematic. The appropriate references are conveniently placed at the bottom of the relevant page, and attention is directed to standard treatises; there is a bibliography at the end of the book, together with author and subject indexes. It is not intended to be a complete survey of the subject, and it may seem unbalanced to some readers. This is perhaps understandable, since Prof. Waterman is mainly concerned to show the contribution of himself and his collaborators. Most of the criticisms which may be made against it are on emphasis rather than of substance. Certain sections are treated as an elementary introduction to the fatty oils industry, while in other sections the author would seem to require the reader to have prior knowledge of the subject.

The first part of the book, four chapters comprising a hundred and thirty pages, is a general description of processes utilized in the winning and refining, possibly with a bias towards Dutch practice, of fats, and of the analytical methods used in their technical and fundamental characterization. The section on methods of examination could have been improved by differentiating, on one hand, between those techniques which have become generally accepted by all the leading authorities and, on the other, those not universally favoured.

The remainder of the book is a study of the hydrogenation process. Certain aspects are well done. There is a detailed treatment, in relation to the researches of the Delft school, of the mechanism of hydrogenation, and a critical survey is made of the important subject of selectivity. Adequate attention

has been given to methods of representation of the course of hydrogenation of mixed glycerides.

Many readers may be disappointed to find that the technology of fat-hardening is dealt with in seventeen pages and the production of hydrogen, one of the essentials in the process, is inadequately covered in a book with such a title; and no assessment of the principal industrial methods has been attempted.

Despite its limitations there is much to be learnt from this book. The hundred and twenty pages on hydrogenation contain a valuable original approach to the fundamental chemistry of the hydrogenation of oils and fats, and for this reason Prof. Waterman's book will be of interest to advanced students and to chemists and technologists in the fatty oils industries.

H. Jasperson

MINERAL NUTRITION OF PLANTS

Mineral Nutrition of Plants

Edited by Emil Truog. (Published in celebration of the Hundredth Anniversary of the Founding of the University of Wisconsin.) Pp. xiii+469. (Madison: University of Wisconsin Press, 1951.) 6 dollars.

THIS volume, published under the nominal editorship of Prof. E. Truog, comprises eighteen contributions by different authors, based on papers communicated at a symposium held in the University of Wisconsin. The main object of the symposium was to provide an opportunity for the exposition of the latest views on mineral nutrition, for the mutual benefit of those concerned in the investigation of particular aspects, and for the guidance of those engaged in the practical cultivation of plants, in fertilizer manufacture and in food industries.

Since potential purchasers of a specialist treatise of this type are to some extent influenced by the reputation of the contributors, it is appropriate that these should be indicated in this notice. They are C. E. Kellogg and A. C. Orvedal, E. Truog, C. E. Marshall, R. Overstreet and L. A. Dean, H. Jenny, J. B. Page and G. B. Bodman, A. G. Norman, T. C. Broyer, H. Burström, O. Biddulph, D. Boynton, J. B. Hester, D. I. Arnon, W. F. Loehwing, R. A. Steinberg, R. B. Withrow, C. H. Wadleigh and L. A. Richards, and H. F. Clements. It is at once clear that there assembled at Madison as distinguished a group of mineral nutrition specialists as is likely ever to be gathered together in one place.

The articles are arranged in logical sequence, starting with the soil and the availability of nutrients therein, then passing to the mechanism of entry of mineral nutrients into and their translocation within the plant, leading to the role of minerals and to the disturbances in metabolism resulting from mineral deficiencies. The introductory article, by Kellogg and Orvedal, presents the thesis that, given the proper application of existing knowledge of soil science and the intensification of research where necessary, the extent to which the food-producing capacity of the world can be increased is practically unlimited. Articles of a specialist nature follow, including a particularly lucid discussion by Burström of the mechanism of ion absorption, and a clear exposition by Jenny of the contact theory of mineral uptake. Papers of an applied nature are provided by Boynton and Hester, relating respectively to the cultivation of the apple and of the tomato and other vegetables used in the canning and soup-manufacturing industries. The second of these is of particular interest, not only on account of the array of statistics, such as that the United States tomato crop takes eighteen tons of zinc from the soil annually, but also because of the instance which it provides of the rapid and successful application of academic research results to the commercial cultivation of crops.

There is inevitably a risk of repetition in a composite volume of this type, and in fact the Lundegårdh theory of active ion absorption receives the consideration of three different authors. A good deal of what is contained in the book was already in print elsewhere, adequate references being in most cases provided; but it is undoubtedly advantageous to have all this information, relating as it does to intimately connected but, for administrative reasons, often quite separately pursued fields of inquiry, assembled together within one cover—for the first time, so far as I am aware.

The book will make a very useful addition to the libraries of those concerned with soil science, plant nutrition and cell physiology. This felicitous arrangement whereby the University of Wisconsin marks its own centenary by an act of signal assistance to those engaged in the study of the plant in relation to the soil is in keeping with the well-established traditions of the University.

G. Bond

PSYCHICAL RESEARCH DISSECTED

The Psychology of the Occult

By D. H. Rawcliffe. Pp. iv+551+11 plates. (London: Derricke Ridgway Publishing Co., Ltd., 1952.) 21*s.* net.

THIS stimulating and highly provocative book is an attempt to describe and analyse the part "played by various types of psychological anomaly in the creation and perpetuation of occult beliefs and practices". The author has cast his net wide and deals briefly with a large number of subjects ranging from lycanthropy to *PK* (psychokinesis). Following in the tradition of the late Ivor Tuckett (1911), the authors of the famous "Dreimännerbuch" (1925), and more recently Joseph Rinn and Johann Kruse, Mr. Rawcliffe is completely unmoved by the flood of modern propaganda in favour of the reality of so-called psychic phenomena. Even the evidence for mental phenomena such as telepathy and clairvoyance leaves him cold. "There is not even a *prima facie* case," he writes (p. 21), "for the existence of 'psi-phenomena', judged from the scientific standpoint." As for the physical phenomena of the séance room, Mr. Rawcliffe finds the evidence scarcely worth considering. To him the whole of the studies of the psychical research worker are mere examples of magic and superstition dressed up in modern garb and often presented behind a façade of statistical jargon which is intended to disguise the faulty character of the original data.

In support of his position he has skilfully put together a mass of material in which the incompetence and credulity of not a few workers in this field are cruelly displayed. Yet he has omitted much that would have strengthened his case and, it must be added, a good deal that would have weakened it. It is clear that he is of the opinion that an explanation of all parapsychological phenomena is to be sought in facts already known, and that there is no need whatever to invoke anything "psychic", which, in

his opinion, implies a return to the mystical, the occult and the supernatural.

In favour of this thesis Mr. Rawcliffe has been at pains to examine a good deal of the literature and has selected a number of instances which illustrate his point of view. Indeed, in one or two cases he is the first to attempt what he calls a "rational" explanation. Thus he considers endophasic enneurosis (unconscious whispering) to be the chief explanation of the majority of the experiments in extra-sensory perception, citing in support of his theory the work of Lehmann and Hansen (1895) and the more recent conclusions in the well-known case of the Latvian peasant girl, Ilga Kirps.

It is when Mr. Rawcliffe attempts to deal with the better class of experiments that his explanations begin to appear somewhat unconvincing. Thus his refutation of the validity of the conclusions drawn by Dr. Soal for some of his work will, I think, scarcely bear expert examination, and his omission of any discussion of the phenomena of such mediums as D. D. Home, Mlle. Tomczyk or Mrs. Piper suggests a bias which is to be regretted.

In spite of its deficiencies, however, this book remains a useful handbook for those who suspect that much of what passes for psychical research and which is often unfortunately supported by leading parapsychologists is scarcely worth the paper on which it is recorded. The book has a useful glossary of technical terms and a selected list of authorities; but the text contains more than the usual number of printers' errors.

E. J. Dingwall

BIOLOGY OF HUMAN STARVATION

The Biology of Human Starvation

By Ancel Keys, Josef Brožek, Austin Henschel, Olaf Mickelsen, Henry Longstreet Taylor. Vol. 1. Pp. xxxii+764. Vol. 2. Pp. viii+765–1386. (Minneapolis: University of Minnesota Press; London: Oxford University Press, 1950.)

THE physiological effects of a shortage of food occupied the attention of many people during the Second World War, and plans were laid by various committees in Great Britain to study them immediately hostilities ceased. In the United States in 1944 Prof. Ancel Keys and his four colleagues decided to put the matter to the test of experiment. They received little encouragement from official sources; but, with the financial aid of various religious and commercial bodies, they launched their great 'Minnesota Experiment'. Sir Jack Drummond, who visited Prof. Keys and saw the experiment in progress, writes that he had rarely come into touch with an investigation "so meticulously planned and so enthusiastically carried through".

The subjects were young men who had registered as conscientious objectors and who were serving in various Civilian Public Service Camps. More than a hundred volunteered for the experiment; thirty-six were selected and, of these, thirty-two stayed the course. After a control period of twelve weeks, during which time the men ate an adequate diet and were subjected to a battery of tests, the period of semi-starvation started. Two meals a day were served, consisting largely of whole wheat bread, potatoes, cereals, turnips and cabbage. These foods provided each man with an average of 1,570 calories a day. The semi-starvation period lasted for twenty-four weeks, and by the end of this time the subjects had lost about 25 per cent of their body weights. The photographs at the end of Vol. 2 provide convincing evidence of this. Then followed the twelve weeks of rehabilitation. For this, the men were divided into four groups of eight, each group receiving a different number of calories, varying from 1,930 to 2,940 a day. These calorie groups were further sub-divided so that some of the men in each received supplements of protein or of vitamins. It was soon realized that the allowances of food during this period were too small and they were increased; but it seems likely that, even so, they were not large enough. In any event, when twelve of the men were given the opportunity to eat as much food as they wanted after the official period of rehabilitation had ended, they managed to consume enough food to provide them with 7,000–10,000 calories a day. The whole experiment ended in December 1945.

The investigators had by this time amassed a vast amount of information about the reactions of the bodies and minds of their subjects to a shortage of food, and they were faced with the problem of putting it all together. They decided to make as complete a job of it as they could, and to try to give a comprehensive survey of world knowledge of human starvation in addition to presenting their own findings. The results of their labours are contained in the two large volumes, running to nearly fourteen hundred pages, at present under review. The work of putting all this literature together demands fully as much admiration as the carrying out of the experiment. The morphological, biochemical and physiological effects of starvation are dealt with in the first volume, and the psychological problems are considered in the second, along with special problems such as the relationship of undernutrition to diabetes, neoplastic disease, and to infectious diseases, particularly tuberculosis.

The various results of the Minnesota Experiment take their place among the findings of all the other authors to whose work reference is made. This makes it difficult to visualize the results of the Minnesota Experiment as a whole; but, on the other hand, it is of great value to compare results obtained under experimental conditions with observations made 'in the field' on undernourished populations. The kinds of foods which the subjects ate during the period of semi-starvation were those which the populations of France, Belgium and Holland were forced to live on during the War, and they were the foods which were most readily available in Germany during the period of greatest food shortage in 1946. Prof. Keys and his colleagues conclude that the changes they observed were due first and foremost to a deficiency of calories and not to any specific protein or vitamin deficiencies. This was exactly in accord with the conclusion of workers who had the opportunity of observing the undernourished peoples of Western Europe.

The second volume closes with a list of three thousand references which, the authors write in the introduction, they have consulted in the original. Even if all the authors shared equally in this task, it means that each of them must have read and abstracted at least six hundred papers. Little wonder that they acknowledge "the forbearance of their wives throughout the years of dedication of time and effort to the present work".

E. M. Widdowson

Steroid Hormones and Tumors

Tumorigenic and Antitumorigenic Actions of Steroid Hormones and the Steroid Homeostasis; Experimental Aspects. By Dr. Alexander Lipschutz. Pp. xi+309. (Baltimore, Md.: Williams and Wilkins Company; London: Baillière, Tindall and Cox, 1950.) 46*s*. 6*d*. net.

PROLONGED or excessive dosage with œstrogen may lead, in either sex, to hyperplasia or metaplasia of certain tissues. This effect, like other effects of œstrogens, can usually be prevented by the simultaneous administration of progesterone or androgens. Allowing for the large number of gonadally active steroids now available, and for the possibility that certain of the growths induced by œstrogens may ultimately become neoplastic, it will be seen that there is here a prolific field of research.

Among those who have worked in this field, Lipschutz and his colleagues occupy a very prominent place, and their extensive and systematic contributions are summarized in the book under review, especially on experimentally induced fibromata. Lipschutz's thesis is briefly as follows. Production of abnormal growth by œstrogens requires that the stimulus shall be not only prolonged but also continuous. Such continuous œstrogenization can easily be effected experimentally, but in the normal animal is usually prevented by homeostatic mechanisms, notably by the capacity of the liver to inactivate œstrogens. Before any of the œstrogen-induced tumours can be regarded as neoplastic, they must be shown to be autonomous, irreversible and independent of the original stimulus. Unless and until that point is reached, the growth can be inhibited by the simultaneous administration of other steroids which antagonize œstrogens. Lipschutz also directs attention to the fact that to a lesser extent the same thesis applies to androgens. The book ends with a useful discussion of the causes and effects of endogenous hormone imbalance.

Prof. Lipschutz is to be congratulated on having written an informative and stimulating book which will be most useful to those who wish to get a sound grasp of this complicated subject. A. S. Parkes

Physical Chemistry for Schools and Colleges

By H. L. Heys. New edition revised. Pp. 453. (London: George G. Harrap and Co., Ltd., 1952.) 9*s*. 6*d*.

MR. H. L. HEYS'S gift of clear exposition and his avoidance of advanced mathematics have long made this book popular with teachers and particularly suited to the average pupil taking the former Higher School Certificate or equivalent examinations.

To the difficult task of bringing the text into line with such of the present-day theories as can be presented at school-level, and at the same time retaining the simplicity of treatment, Mr. Heys brings a commendable courage and a sound critical judgment. Thus he introduces and justifies the Brönsted–Lowry conception of acids and attempts to apply it; but he avoids the theory of Lewis. Again, besides discussing the covalent and co-ordinate bonds, he repeatedly shows their relation to chemical behaviour. Besides adding a new chapter in which he has grouped some related phenomena under the heading of "Electrochemical Series", Mr. Heys has extended almost every section, as well as bringing in additional topics such as chromatography, the structure of metals and over-voltage. As a consequence, the size of the book has been increased by 117 pages. The revision has been thoroughly well done, and the book can be strongly recommended.

Les biocatalyseurs

Par Prof. Max-Fernand Jayle. Tome 1: Enzymes, substrats, vitamines et hormones. Pp. 260. (Lons-le-Saunier: Impr. M. Declume, 1951.) 950 francs.

THIS is, in fact, the first volume of a treatise on biochemistry, and deals with the biochemical reactions of living organisms and the agents which assist them. (A second volume is announced which deals with clinical biochemistry, especially of blood and urine.) This book can be described as an excellent elementary account which medical students and students of biochemistry and physiology could read with profit. It is up to date in many directions, for example, in giving what is known about the structure of insulin. Some 'anti-vitamins' are mentioned; but no account is offered of natural antibiotics—possibly because their mode of action is still obscure. The book suffers greatly from a complete absence of references. Many names are mentioned, but nothing to indicate where the student could look for further information.

Atlas of Human Anatomy

By Franz Frohse, Max Brödel and Leon Schlossberg. Explanatory Text by Dr. Jesse Feiring Williams. New edition. Pp. 88. (London: George Allen and Unwin, Ltd., 1952.) 16*s*. net.

THIS new revised edition of the "Atlas of Human Anatomy" reproduces, in pocket size, the Frohse–Brödel wall charts and the Leon Schlossberg's supplementary charts. In addition, there is a short explanatory text by J. F. Williams.

Most of the illustrations are reproduced in colour; but, in many instances, they have been reduced too much to be of any real value. One or two of the new illustrations, for example, those on pp. 63 and 66, are made very much too large for the details they show. A number of the illustrations, such as the upper figure on p. 55, are confusing. No explanation is given of what structures have been removed.

The text in many places is very vague and often inaccurate; for example, on p. 20 the following statement is made: "The left ventricle pumps blood *over* the entire body (page 41) except the lungs which are supplied by the action of the right ventricle". Many statements are made which are much too generalized, even for a book of this description.

W. J. Hamilton

The Chemical Technology of Dyeing and Printing

Vol. 2: Substantive, Basic, Acid and Pigment Colors, Aniline Black, and Dyestuffs for Acetate Rayon and Synthetic Fibers. By Dr. Louis Diserens. Translated and revised from the second German edition by Paul Wengraf and Herman P. Baumann. Pp. xii+446. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1951.) 96*s*. net.

THIS is by no means a 'readable' book, though it may be of value to the practical man as a collection of recipes and instructions which appear to be authentic and are certainly specific in detail. The price alone seems likely to limit its sale to those who will find it of practical value in their everyday work.

S. M. Neale

NATIONAL PHYSICAL LABORATORY, TEDDINGTON

OPEN DAY

AFTER the extended series of Open Days held at the National Physical Laboratory last year in celebration of the Laboratory's jubilee, the corresponding function this year was confined to a single day, May 23, which was also made the occasion of the annual visitation and meeting of the General Board. In a day of ideal summer weather, nearly one thousand visitors were entertained at the Laboratory. The number of items of research on show was much less than was exhibited last year; but more than one-quarter was concerned with new work.

In the Light Division, a demonstration was given of a development which has recently created considerable interest, namely, transparent electrically conducting films on glass. As a result of methods developed at the Laboratory, it is possible to deposit on glass exceedingly fine films of gold, of the order of a quarter of a millionth of an inch thick, which have an electrical resistance as low as 10 ohms between the opposite sides of a square sample, and an optical transmission as high as about 80 per cent. These results are closely reproducible, so that, although these effects have so far been produced only on small areas of glass, the extension of the idea for the purpose of de-icing aircraft windows and like applications appears to be possible. Also in this Division, further exhibits were shown of recent developments in the manufacture of diffraction gratings by the Merton–N.P.L. process. Gratings so far produced with five thousand lines to the inch are finding a ready application in the field of infra-red spectroscopy, where they are replacing costly prisms of such materials as lithium and calcium fluoride in the work of exploring molecular structure.

Several demonstrations were given by the Aerodynamics Division which are of particular importance in the subject of high-speed flight. One of the problems being investigated concerns the effect which may be produced when the boundary layer on a wing or other body moving at high speeds meets a shock wave. In these circumstances it may thicken or separate from the surface, and thus the shape and strength of the shock wave may be modified. Interaction problems of this type are important, and it is essential to understand them in order to allow for the scale effects which result from the use of small-scale models in high-speed wind tunnels. Detailed studies of this type of interaction have been in progress at the Laboratory for several years, and recently a small wind tunnel has been built in which the range of Mach and Reynolds number which can be covered is greater than had been possible previously. The Mach number can be varied from $1\frac{1}{2}$ to 4 by changing the shape of the nozzle used to produce the supersonic flow. The stagnation pressure of the air entering the tunnel can be varied between $\frac{1}{2}$ and 20 atmospheres absolute, thus giving Reynolds numbers from $0{\cdot}5 \times 10^6$ to 20×10^6 on the flat plate. Results obtained so far indicate that changes of the Mach or Reynolds number have a considerable effect on the interaction. Another section of the work concerns research on delta and arrowhead forms of fighter aircraft. An arrowhead wing was shown in the low-turbulence tunnel, where it was forced to oscillate in pitch by applying a reciprocating force through a spring; movements in the wings were recorded photographically. This work is of importance as this particular type of aircraft, especially when travelling at high speeds, is liable to give rise to undamped pitching oscillations, which make the machine unstable and difficult to control.

The Electricity Division had on show a method for the precise measurement of dielectric constants of pure liquids. These measurements are being carried out in the first instance on benzene, which is being regarded as a standard liquid. The measuring cell consists essentially of electrodes in the form of concentric tubes of platinum fitted with a guard ring, which are mounted in a glass container. Benzene, which is supplied in a highly purified form, is distilled direct into the cell after it has undergone treatment to remove traces of dissolved gases and water. The capacitance of the cell is measured when the dielectric medium is first air (or a vacuum) and then benzene, and the ratio of one capacitance to the other gives the dielectric constant of the benzene. The measurements are being made in the first place at 1,000 c./s. and over a temperature range of 5–30° C. The High Voltage Laboratory has continued work on the measurement of surge voltages, and a divider for use in such measurements was shown. These dividers can be constructed from resistors or capacitors or combinations of both; but, whichever is used, the essential requirement is that the wave-shape of rapidly changing phenomena should be faithfully produced at the oscillograph with a reduction ratio which can be accurately determined. The chief source of error for all forms of divider arises from the earth capacitance of the high-voltage arm; but the effects of inductive residuals in the low- and high-voltage arms cannot be neglected for surges occupying a microsecond or so.

The pilot model of the Automatic Computing Engine which was designed and made in the Electronics Section of the National Physical Laboratory has now been transferred to the Mathematics Division, where it is being used for high-speed computational work. Although the pilot model was originally intended merely as the forerunner of the final machine, it has proved to be particularly useful and will continue to be used while an engineered version and also the final machine are being produced.

In the Metallurgy Division a new method was demonstrated for the preparation of small specimens for tensile tests. In the preparation of specimens of the order of 1/16 in. in diameter, the strain produced in the surface layer by machining is important, although for larger specimens it can usually be ignored. The problem of obtaining small specimens by some other method was solved by making the specimen the anode in a rather unusual electrolytic cell. A jet of suitable solution plays on the blank while it is rapidly rotated and at the same time moved to and fro along its axis at a uniform speed. A current passed between the blank as the anode and a cathode in the jet causes the blank to be

dissolved away gradually and uniformly until the desired size is reached. If the current density is high enough and the electrolyte suitable, a truly electro-polished surface is produced which is free from irregularities under a high-power microscope, as well as being free from strain. Another exhibit shown by the Metallurgy Division concerned the production of titanium. Although titanium is the fourth most abundant metal in the earth's crust and is widely distributed, it is only since the development of the magnesium-reduction process within the past decade that the metal has shown industrial potentialities. Previously it had not been possible to prepare the metal in a sufficiently pure state, and its true properties are shown only when in this condition. Research is being carried out at the Laboratory on new methods of preparation of the metal and on the constitution of titanium–oxygen and titanium–iron–oxygen alloys. In connexion with research on atomic structure, an X-ray spectrometer capable of dealing with large and small specimens has recently been constructed in the Metallurgy Division. In this instrument, the X-ray intensity is recorded by a Geiger–Müller counter which can be positioned to an angular accuracy of ± 17 seconds of arc. The pulses in the counter are amplified and recorded, and in this way quantitative measurements of diffraction maxima can be achieved in a fraction of the time required to expose and process a photographic plate. To eliminate errors due to variation of the X-ray source, a monitor Geiger–Müller tube is used for measuring the beam incident on the specimen. When the monitor tube has received a predetermined number of counts, it automatically stops the diffraction tube, the count of which thus corresponds to a fixed quantity of X-radiation on the specimen. The overall accuracy attainable is about 0·5 per cent.

Demonstrations were given in the Metrology Division of emitters of highly reproducible waves of light which are being used in connexion with the measurement of distances of up to 0·5 m. to an accuracy corresponding to one-millionth of an inch in ten inches. These sources use pure isotopes either of mercury or of krypton, both of which are now obtainable in sufficient quantity. During recent months, four N.P.L. gauges, the largest being 10 cm. long, have been sent to two other standards laboratories in Europe for measurement in terms of these wave-lengths of light. The results obtained at the three laboratories are in very good agreement, all the measured values for each gauge lying within a range of $\pm 1 \times 10^{-6}$ in. Measurements are also continuing with radio waves 12·5 mm. in length for the purpose of being able to measure up to distances of about 1·6 m. by interferometry. The accuracy so far attained is of the order of 0·0001 in., and the technique which has been developed shows considerable promise of extension to distances of 30 m. or more. A re-determination of the density of mercury is to be carried out in connexion with the National Physical Laboratory standard barometer, and in order to do this a 3½-in. cube of sintered tungsten carbide has been prepared in the Metrology Division workshop with a standard of workmanship which is thought to be unsurpassed. The faces of the cube have been lapped to within 10×10^{-6} in. of flatness, and a little short of this in parallelism, while the edges and corners have also been carefully finished. It is hoped that this perfection of geometric form will permit the volume to be determined from interferometric measurements of the linear dimensions. The cube will then be weighed in air and in mercury in which, by virtue of its density, it will just sink. The accuracy which it is hoped to attain corresponds to better than 0·001 mm. of mercury in the measurement of atmospheric pressure and less than 0·0001° C. in the measurement of temperature at the steam point.

In the Physics Division a new method has been devised for measuring the elastic properties of materials over a temperature-range from near the absolute zero to above red heat. In the new equipment the specimen is lightly suspended in the centre of a long tube and either cooled by surrounding it by cold liquids jacketed in a special form of Dewar flask, or else heated by electrical means. The specimen has attached to it long nickel filaments which can be used for setting it into oscillation and also for measuring the oscillations, since nickel has the property of changing magnetic variations into vibrations and vice versa. The precision obtainable is of the order of 0·03 per cent in favourable circumstances, and thus enables a knowledge of the elastic moduli and of the anelastic behaviour to be obtained. This information is of particular value because of the present tendency for materials, such as turbine blades, to be stressed very highly, even at temperatures in excess of 1,000° C. In another part of the Physics Division, a new Smith bridge has been built for the purpose of measuring normal temperatures to an accuracy of ± 0·0001° C.

In the Ship Division, developments have taken place in the technique for cutting propellers. In the latest method thin steel templates are first cut from an enlarged drawing through a pantograph mechanism, a scale ratio of 5 : 1 being employed. Then the templates are clamped around cylindrical formers in such a way that they give a correct skeleton replica of the face or back of the screw. The formers are mounted on a shaft carrying the screw, and this shaft is rotated and advances so that a follower maintains contact with the template while an electrically driven bandcutter traces the correct section on a metal screw blank. On the final version of the machine it is hoped to cut all four blades at once. A new torsionmeter which had been designed and made in the former Engineering Division workshop was also shown. Although the operating principle is similar to that of the commercial type of instrument, the deflexion is transmitted from one end of the gauge length to the other by means of a small tube lying parallel to the shaft instead of by a shell concentric with it. Thus a very considerable reduction in the size and weight of the instrument has been achieved. The instrument is carried on hardened points bearing on the shaft and is clamped to it by chains ; a range of shaft diameters of 14–22 in. can be accommodated. Experiments are being carried out in the water tunnel on the effect on the cavitation characteristics of a ship's screw arising from a non-uniform velocity distribution of the water. Gauzes of varying mesh inserted in the tunnel circuit are used for producing the appropriate variation in velocity.

In the High Temperature Mechanical Properties Section, an investigation is in progress on the variation of fatigue strength over a speed-range of 10–8,000 cycles per minute on a mild steel for temperatures up to 500° C. It has been found particularly important to investigate the effects resulting from the use of the higher frequencies.

Visitors were also able to inspect the various items of routine test work in the Test House and to discuss problems connected with the maintenance of standards of quality.

VIRUS DISEASES OF FRUIT CROPS

By Dr. A. F. POSNETTE and Dr. R. V. HARRIS

East Malling Research Station, Kent

RECENT developments in the study of virus diseases of fruit crops, with special reference to strawberry and tree-fruits, was the subject of a 'Members' Day' at East Malling Research Station on July 2, when about a hundred visitors were present. The bulk of work on raspberry virus diseases, started in 1920, was transferred in 1942 to the intensive raspberry-growing districts of south-eastern Scotland and continued under the auspices of the Agricultural Research Council and the direction of East Malling; the staff of this investigation was transferred to the newly formed Scottish Horticultural Research Institute in April 1951. The considerable progress made during this period of nine years in our knowledge of the many viruses infecting cultivated *Rubus* species and their complex associations is the subject of a series of research reports at present in course of publication. Work on viruses of blackcurrant and the other *Ribes* species begun in the early 'twenties has recently been resumed at East Malling with the identification of three new viruses, two on blackcurrant and one on gooseberry.

Strawberry Virus Diseases

This work started in 1930 with the distinction of two symptom-types in field plantations, yellow-edge and crinkle. In more recent analytical work, for which Dr. I. W. Prentice was chiefly responsible, these diseases were interpreted in terms of combinations of viruses assigned to three principal groups, (1) mild crinkle, (2) yellow-edge and (3) severe crinkle, on the basis of their differential persistence in the insect vector *Pentatrichopus fragæfolii*. With this advance in the knowledge of the causal viruses, the early grouping of strawberry varieties as virus-tolerant or virus-sensitive is now being superseded by a more exact description of the reaction of each variety to the various viruses and their associations; work on this aspect of the problem is at present seeking a virological interpretation of the loosely called 'break-down' of virus tolerance (in its early sense). This degeneration is a common and disturbing phenomenon in plantations of the leading commercial varieties, Huxley's Giant and Auchincruive Climax. Evidence was recently obtained of a degenerative effect on a clonal race of Huxley, infected only with so-called mild-crinkle virus, when it became infected with a further virus in this low-persistence group. Infection of virus-free Climax plants with the viruses of this group 1 complex, together with group 2 viruses, caused some stunting; but evidence has been obtained recently that another distinct virus is responsible for the severe 'break-down' frequently found in plantations.

Two other diseases, which are prevalent in plantations of the recently introduced Auchincruive Climax variety and are complicating the diagnosis and control of the virus diseases noted above, are being studied. 'Green-petal disease', in which flower and fruit abnormalities are associated with a leaf chlorosis, is thought to be of virus origin, and tests of transmission by grafting and insects are being made. Chloroses similar to descriptions of the 'June yellows' disease in North America are also causing disquiet among growers and propagators of planting stock, and two distinct symptom categories have been distinguished: transient chlorosis of the young leaves in the spring, and a chimæral streaking and speckling which persists throughout the season. The latter form, which has also been observed in varieties other than Climax, is commonly associated with a reduction in vigour. Neither of these forms has so far proved to be transmissible by graft. A third disease, 'sudden yellows', which produces symptoms on Royal Sovereign strawberry easily confused with those of severe yellow-edge, has been shown, however, to be non-virological in origin. Its real cause still remains obscure.

The information from this analysis and evaluation of the viruses concerned in the economic diseases, and from the study of their insect-vector relations, provides the basis for the following studies bearing directly on the problem of control: (1) natural virus ingress and spread in the field plantation, and methods for checking it, and (2) the production and maintenance of planting stocks (runners) free from virus diseases. An approach to the former is being made from four directions, namely, a search for alternative vectors, and for alternative virus-hosts, a determination of the seasonal times of spread of each of the virus components, and, with the Entomology Section, a study of the modification of the pattern of virus spread following the control of insect vectors by means of insecticides. The recent discovery of new aphis vectors was reported in *Nature*[1], and two species of *Potentilla* have been shown to be, in one case a potential, and in the other case an actual, alternative host of strawberry viruses. Time of seasonal spread is being studied by the successive exposure for limited periods of *Fragaria vesca* indicator plants in a plantation of commercial varieties where the viruses are known to be present. The effect of control of vectors by insecticides on the pattern of spread of a virus is being determined from data collected from replicated plots planted with virus-free Royal Sovereign and *F. vesca* plants and subject to complete, partial and nil schedules of spraying with a systemic insecticide.

The selection and maintenance of healthy planting stock, the second objective, is based on transmission tests to indicator species and varieties by grafting and by artificially manipulated insect-vectors, followed by intensive methods for the rapid preliminary multiplication of the selected plants under insect-proof glasshouse conditions.

Finally, experiments on the application of heat-therapy to varieties of which no completely virus-free clones are obtainable have yielded positive results. Thus runners of certain varieties infected with viruses of group 1 and subjected to heat treatment have afterwards failed to induce any detectable symptoms on *F. vesca* indicators. This work is being extended.

Virus Diseases of Tree Fruits

Preliminary observations and experiments on certain suspected virus diseases of apple, pear and cherry were started by Prentice in 1948, and this programme was enlarged and intensified with the arrival of Posnette in 1949. Since then, research has followed two complementary lines: (1) the classification and description of visual symptoms found in orchards, and (2) a critical examination of material thus located by attempted graft-transmissions from trees showing each type of symptom and comparable

trees not showing them, to a range of possible indicator varieties and species. In the course of this work an appropriate range of standard indicator hosts for each virus group is being determined, and improved grafting techniques for obtaining quick test results have been devised and put into general use.

The problem as it concerns the scion and rootstock of tree fruits is a dual one, the effect of a rootstock infection being a permanent and growing source of tree infection unless it is eliminated, and that of scion-tree infection more localized and more likely to be eliminated in the normal course of propagation. Also, a combination of stock and scion each infected with different viruses may synthesize complex diseases, which may be disseminated if stocks on which grafts have failed are regrafted or returned to stoolbeds for continued propagation. In this brief survey of present early trends and discoveries, the scion and stock problems will therefore be dealt with separately.

Virus diseases in scion varieties.

Apples. Apple mosaic virus was found to exist in several strains of different virulence, and strains causing extensive leaf chlorosis and defoliation of a variety will probably affect its yield. But varieties differ greatly in their sensitivity to these strains, so that a strain can only be defined as severe in relation to a specified variety, and hence the danger of 'top-grafting' a sensitive on to a tolerant variety. The effects of the rubbery wood virus on a wide range of varieties, additional to the sensitive variety Lord Lambourne, is being determined, following the discovery of the wide distribution of these diseases through infected stoolbeds (see below).

Pear. Besides stony-pit, two diseases of the vein-banding and leaf-flecking type have been identified and appear to have a stunting effect on quince-seedling indicator plants. The possible importance of these viruses in stock-scion incompatibility phenomena is being studied.

Cherry. Four groups of symptoms have been identified and are being studied by graft transmission to a range of species and varieties: rasp leaf, tatter leaf, rosette and rusty mottle. The three latter have reduced the vigour of a clonal rootstock (*F*12/1) by about 20 per cent (girth and height) in two years. Rasp leaf is a more severe disease in its effects, not on *F*12/1, but on most commercial varieties. As its occurrence is comparatively rare, total loss from rasp leaf is probably much less than that from more commonly distributed viruses such as rusty mottle.

Plum. The common vein-banding or line pattern leaf symptoms in plum are probably caused by several viruses. In general, plums are more tolerant to virus diseases than are cherries, and viruses from almost symptomless plums have been found to cause severe leaf-necrosis on cherry. Two recently discovered symptom types on plum, a leaf roll and a bark splitting, are both potentially serious diseases on certain varieties, particularly the gages.

Virus diseases in root-stocks.

Vegetative races of root-stocks hitherto developed at East Malling without reference to the ingress and subsequent dissemination of viruses are being extensively surveyed, with the following results to date.

Apple root-stocks. Some stools of *M*I and *M*IX at East Malling were found in preliminary tests to be infected, without symptoms, with rubbery wood virus. Other varieties of the Malling series from commercial sources were also found to be extensively infected with this virus, and arrangements are in hand to continue the survey on a wider basis with the aim of re-selecting and developing virus-free clones where necessary.

Quince root-stocks (for pear) are under investigation and some infection has been identified.

Plum root-stocks are mainly symptomless carriers, and preliminary tests have detected a widely distributed virus in common plum and Marianna stock. There is some, but probably less, infection in the Myrobalan *B* and Brompton stocks.

Cherry root-stocks. Some clones of Mazzard selections have been found to be infected with ringspot; but the most important selection, *F*12/1, is mainly free from virus. The latter stock, unlike those of plum, commonly shows symptoms when infected, and beds can then be 'rouged' at sight; *F*12/1 is, in fact, used as an indicator-host in our studies of stone fruit viruses.

Selection of healthy propagating stock and indexing of trials. The first step towards the control of these diseases of tree fruits is their elimination from the material used for propagation. This involves not only the re-selection and raising of virus-free root-stocks, but also the selection and distribution of virus-free scion material. This work has already begun, and a survey, by graft-indexing, of virus diseases in existing trials at this Research Station is being undertaken. Plans are also contemplated for investigating the natural vectors of these diseases.

[1] Posnette, A. F., *Nature*, **169**, 837 (1952).

EDUCATION AND TRAINING OF METALLURGISTS

THE presidential address by Prof. Hugh O'Neill to the Institution of Metallurgists given on June 26 was concerned, first, with the education of metallurgists and, secondly, the maintenance of a high standard of professional conduct.

Whether the founders of the Institution intended it or not, it is a company showing a strong resemblance to the early craft guilds. The three grades of membership, like the corresponding degrees at the universities, were grades through which every common man could pass. They were not social classes; they were degrees and not castes. Professional qualifications were required in many countries during the Middle Ages before a man could practise as a metallurgist. Thus in 1438 Charles VI of France decided that nobody in any town, village or hamlet in Dauphiné could make iron or steel if his competence had not been officially recognized. The old worker, and those who wished to become workers, were examined by an official assisted by two or three experts, who judged their aptitudes and experience. Just as in the days of the Guilds when the apprentices were not only taught the trade, but also received some general education, so is the Institution interested in the training of its members. It is recorded that a goldsmith's apprentice in 1494 agreed to serve ten years instead of nine, provided that his master would keep him one year at a writing school. Among the goldsmiths, fines were inflicted for failing to have the apprentices taught reading and writing. These craft guilds were friendly

societies, concerned with the welfare of the *whole* man. They had their religious observances and their festivities.

There is still an element of dissatisfaction, which university teachers themselves share, with the training at present given to many students of metallurgy. Someone wrote to me to say that after interviewing several hundred science graduates he concluded that in all the British universities insufficient attention is directed to the underlying science and philosophy of the subject. He believed that teaching in the history and philosophy of science, plus an account of scientific method, with further philosophical teaching on the nature of truth, are essential ingredients in the training of any man of science who wishes to describe himself as well educated. A further criticism of current training is that: "The educated scientist knows that his science is derived only from a part of experience, and that it does not, and cannot, concern itself with the most important aspects of human life. The universities are to blame. They were instituted to give an education, but to their science students they give little more than technical training. They are, in general, expending far less effort in making wise men and good citizens, than in turning out good employees for commerce and industry. This can be remedied in part at least by insistence that the study of the nature of science should be a necessary part of the training of scientists, and should enter into every final examination".

Exactly one hundred years ago there was penned in Birmingham a famous discourse entitled "Knowledge Viewed in Relation to Professional Skill". John Henry Newman was outlining his ideas about universities, and advocating "liberal education" combined with specialist studies as a definite means of "cultivating the intellect". According to Newman ". . . the man who has learned to think and to reason and to compare and to discriminate and to analyse, who has refined his taste and formed his judgement, and sharpened his mental vision, will not indeed at once be . . . an engineer, or a chemist, or a geologist . . . but he will be placed in that state of intellect in which he can take up any one of the sciences . . . with an ease, a grace, a versatility, and a success, to which another is a stranger".

Some writers would claim that science itself is an adequate basis for the life of a university or nation, especially because of its sociological developments. I must, however, mention a hilarious essay written in this connexion by a serious scientist, which ends thus: "We can, and should, laugh out loud at scientists and this will be the very best way to prevent them from regulating us, or averaging us, or conditioning us to synthetic happiness. For what are they doing? The most laughable thing in the world. They are all crowding round and bowing low before a Sacred Cow". Without being cynical about science we need not become worshippers. In the last century it avoided metaphysics, whereas to-day we have Schrödinger stating: "I consider science an integrating part of our endeavour to answer the one great philosophical question which embraces all others, the one that Plotinus expressed by his brief—*who are we?*, and more than that; I consider this not only one of the tasks, but *the* task of science, the only one that really counts". Sir Walter Moberly, in discussing how the universities should attempt to implant a wide culture, has recommended a limit to religious neutrality, and an active probing of the common values which are held by most men.

It is generally agreed that intense specialization at the undergraduate stage should be avoided. In the words of Prof. Woodward, no one should receive an honours degree without showing "that minimum of general understanding which differentiates education from technical skill". Fortunately in Britain, with its independent universities, we have largely avoided what an American professor has sadly described as the assembly-line technique: "The *part* affixed in this industrial process is the *course*. . . . The course is a neat unit of knowledge, complete in itself, duly fastened to the student's mind, inspected, passed—forgotten. Once it is on, it is on, and we do not have to worry about it any more. When a student has had all the courses bolted on, we look him over to see that nothing has been forgotten, we add up the credits that the courses are worth, and if what we find agrees with the specifications . . . we give him a degree which signifies that he has a college education". The dilemma arises, however, in connexion with the distribution of time for all the work to be done. Some will take the view that the life of Britain depends upon the discovery, development and export of high-quality specialities. For this first-class men of science are required. It still seems to me, however, that we should maintain the broad basis for the bachelor's degree, and intensify specialization in postgraduate work.

The question may be asked: is there such a thing as 'cultural metallurgy'? Prof. John Read recently developed an earlier opinion that "Chemistry itself may become a cultural and humanistic instrument of high value". To that may be added the following statement of Lord Waverley (formerly Sir John Anderson) in his 1951 May Lecture to the Institute of Metals: "I wish it could be universally recognized that scientific studies no less than the humanities have a cultural value, and that applied science is not inferior academically to pure science". For metallurgy to have any humanistic qualities it would probably have to include the history of the subject, and this indeed was the main point of Read's lecture.

How are we to set up and maintain a high standard of professional conduct? This is a moral matter, and increasingly one hears the expression that there is no morality or culture without religion. If we pursue the analogy with the craft guilds mentioned earlier, we find a general understanding that guild conduct should be based on definite religious principles. There would, of course, be hostility from some quarters at attempts to bring Christian principles directly into the sphere of professional conduct, but one cannot help noticing that at a meeting of the representatives of British, French, German and Italian steel industries at Caux, the great need for absolute moral standards in industry was emphasized. There is, however, another direction in which metallurgists in high positions may have to take a definite line regarding their professional conduct. In the development of primitive regions metallurgists should use their influence to see that the conduct of the enterprise corresponds with the natural rights of mankind.

I would conclude by a quotation from a letter signed by "A Professor", presumably American, on "What do we in the Universities believe?":

". . . Underneath our devotion to the fictitious reality, which the physicist at the Einstein level has

destroyed, lies sleeping a faith in the existence of a moral universe; in the existence of a natural law which gives to man certain inalienable rights; in a Divine Creator of which we are each a tiny spark. . . . But we are scarcely aware of these foundations far beneath our everyday lives. . . . Only when man-made laws challenge man's inalienable rights do we realise whence comes our belief in these rights".

F. C. Thompson

OBITUARIES

Sir Lindsay Scott, K.C.B.

Sir Lindsay Scott, who died on June 17, was an outstanding example of the finest tradition of the amateur in the field of humane studies. A Civil servant fulfilling the exacting duties of a senior official in a war department in peace-time and during hostilities, he nevertheless made a notable place for himself in British archæological research by his resolute determination to match his work against nothing less than that of the highest professional standards in the field or in the museum and library. With a naturally vigorous and original mind, sharpened and disciplined by academic training, he brought to his studies of British prehistory a freshness and directness of approach which was always well ballasted by precise and detailed documentation, and illuminated by direct personal experience. He was, in the eighteenth-century sense of the word, a 'curious' person: his reading was wide and unconventional, and in particular his knowledge of the byways of English literature from its beginnings to the nineteenth century was as varied and unexpected as it was entertaining to his friends, and to this he added a robust and competent command of the practical skills of the countryman and the sailor.

His work was specifically directed to problems of Scottish prehistory, and his main excavations were carried out in the Outer Isles, where perhaps he felt most at home; but these local studies were invariably made within the framework of European prehistory as a whole, and he carried on an amused, but none the less sincere, campaign against provincialism and isolation in such researches. Always provocative (sometimes deliberately and healthily so), his contributions to the archæology of Scotland, both in the form of excavations admirably carried out and meticulously recorded, and in subsequent comment upon the wider aspects of the problems involved, will remain as a permanent memorial to his immense energy and to his devotion to exacting standards of scholarship. These, and his work on the Council for British Archæology and as president of the Prehistoric Society, have ensured him a place among the more powerful forces in the post-war development of prehistoric studies in Great Britain.

Stuart Piggott

Mr. F. W. H. Migeod

Frederick William Hugh Migeod was born on August 9, 1872, in Chislehurst, Kent, and went to school in Folkestone. When he was seventeen he joined the pay department of the Royal Navy, and although he had a love for the sea and an interest in those who serve in ships, he was not destined to devote his life to it. After nine years he left the Navy and in 1900 he joined the Colonial Civil Service. All his subsequent service was in Africa, and most of it in West Africa, though he made several important and hazardous journeys across the continent. His curiosity concerning the languages and customs of the various races was insatiable, and his researches resulted in five volumes on languages and four quite considerable travel books. Wherever he went he observed closely, and he amassed a store of natural history knowledge that he used in later writings.

In 1925, when the British Museum East Africa Expedition was left leaderless through the death of W. E. Cutler, Migeod volunteered from England for the post, and intermittently for the next four years or so he acted as general overseer of the operations. On the whole, he had little success in this, and it is paradoxical that through the nature of the work he came into the public eye much more than he ever did through his able and successful studies in folk-lore and language. It is only fair to say that Migeod in these later years did not claim much for his East African adventure.

Migeod's years of retirement in Worthing were characteristically busy. He wrote a book, "Earliest Man", and another volume, "Aspects of Evolution", which displayed a rather fundamentalist point of view; but also revealed a surprising range of observation and width of knowledge of the literature. He also wrote a survey of Worthing.

Migeod was a Fellow of the Royal Geographical and the Royal Anthropological Societies for many years. He had been president of the Worthing Archæological Society in 1927 and he was re-elected in 1938. He also entered local government as a town councillor, eventually becoming an alderman both of Worthing and of the County of Sussex. He was for many years chairman of the local sea-cadet force.

His manner of speech and bearing sometimes gave an impression of arrogance; but in fact he was a kindly and friendly man and an admirable host. Fortune seldom shone on him. His married life was happy but brief, and his wife died many years ago. For the last year or two he had been ill and much alone, and the end came on July 8.

W. E. Swinton

Prof. Tadeusz Estreicher

Prof. Tadeusz Estreicher (Thaddaeus Estreicher-Rozbierski), a member of an ancient and cultured Polish family and one of Poland's most distinguished and versatile men of science, died in Cracow on April 8. Son of Karol Estreicher, bibliographer and director of the University library, he was born in Cracow on December 19, 1871. He enrolled as a student in the famous Jagiellonian University of Cracow, founded in 1364, where he became a favourite pupil of Karol Olszewski, the celebrated chemist. In 1894, at the request of Sir William Ramsay, Olszewski had begun experiments on the liquefaction of argon; Estreicher participated in this work with distinction, and graduated Ph.D. in 1897. After working in the laboratories of van 't Hoff (Berlin), Ostwald (Leipzig) and Ramsay (London), he returned to Cracow as a *Docent* in inorganic and analytical chemistry; at the same time he helped to modernize Olszewski's laboratory. A further year's work with Abegg (Breslau) was followed by his appointment, in 1906, as professor of inorganic and analytical chemistry at the University of Fribourg, in Switzerland, a chair which he

occupied until he was recalled to succeed Olszewski in Cracow in 1919.

Here he was faced with the difficult task of rehabilitating a department which had been devastated during the First World War. In 1923–24 he was dean of the faculty of arts, and in 1926 he was made director of the Pharmaceutical Department in the University of Cracow; his work in the latter capacity resulted, in 1947, in the elevation of this Department to the dignity of a faculty. Meanwhile, at the outbreak of the Second World War, he was doomed to undergo the terrible experience of imprisonment in the concentration camp at Sachsenhausen, following the arrest of himself and many others on November 6, 1939. In this camp a score or so of his colleagues perished, among them his brother Stanislaw, who held a chair in the faculty of law. Although Estreicher survived, he never regained his normal health. When he returned to Cracow upon his liberation the University had ceased to function, and for a time he was obliged to eke out a meagre living as a proof-reader. With the re-opening of the University he resumed his chair; but his health deteriorated so gravely that he soon felt called upon to resign.

Estreicher was vice-president of the Committee of the Polish Pharmacopœia and an active member of the Committee of Pharmaceutical Science of the Polish Academy of Arts and Sciences. He was also a leading organizer of the garden of medicinal plants in Cracow. His researches dealt particularly with the behaviour of gases at very low temperatures. On this theme he published many original papers in German, Polish and British scientific journals. In 1905 he translated into German Travers's well-known work on the experimental study of gases, and in 1915 he published his own book entitled "Kalorimetrie der niedrigen Temperaturen". For the "Polish Biographical Dictionary" he wrote authoritative notices of Kostanecki, Wróblewski and Olszewski, three Polish men of science of the first rank.

First and foremost a chemist, Estreicher was a man of great erudition and varied interests. He was an accomplished classical scholar, a fluent linguist, and a lover of music and the fine arts. Himself an artist of merit, he assembled a fine collection of modern Polish paintings. His writings included essays on the Polish language and literature, and he published also an interesting monograph on the 'Jagiellonian Globe', a valued relic dating from 1510 and preserved in the Jagiellonian Library at Cracow. He cherished a life-long ambition to write a history of Polish chemistry; but although he collected much material and had the ideal equipment for this task he was never able to find time for it. Towards the end of his life he lost both sight and hearing; but as his letters (often dictated in German) testified, he kept to the end his marvellous memory and his clear and alert mind. This remarkable man of science might well have taken for his motto: *Homo sum: humani nihil a me alienum puto.* JOHN READ

NEWS and VIEWS

Electrical Engineering in the Manchester College of Technology: Prof. J. Hollingworth

PROF. JOHN HOLLINGWORTH, who retires from the chair of electrical engineering in the Faculty of Technology in the University of Manchester at the end of August, was educated at Bradfield College, Peterhouse (University of Cambridge), and the Central Technical College (University of London). During the next nine years he was in turn demonstrator at the Central Technical College, lecturer at the College of Technology, Manchester, and held a commission in the Royal Air Force. He was appointed scientific assistant at the National Physical Laboratory, a position which he held for eleven years. During this period he published a number of papers on the propagation of radio waves and allied subjects. In 1932 he was appointed professor of electrical engineering in the College of Technology, Manchester, and under his direction the department has developed in many directions, notably in the teaching of electronics, servo-mechanisms and high-voltage engineering.

Dr. Eric Bradshaw, M.B.E.

DR. ERIC BRADSHAW, who succeeds Prof. Hollingworth on September 1, was born in 1909 and was educated at the King's School, Grantham, and at the Faculty of Technology, University of Manchester, where he graduated in 1930, taking his master's degree a year later. After a course at the works of the British Thomson-Houston Co., Ltd., Rugby, he joined the staff of the Royal Technical College, Glasgow, where he remained until 1944, during which period he took his Ph.D. degree. He was then appointed special lecturer in high-voltage engineering at the College of Technology, Manchester. He is joint author of a number of papers in the fields of high-voltage measurement and electric power-supply. Dr. Bradshaw has served on several committees of the Institution of Electrical Engineers and is now vice-chairman elect of the North-West Centre of the Institution. He has for some years been tutor and lecturer at the Ministry of Education Engineering Summer Schools. He founded and is now editor of the *Bulletin of Electrical Engineering Education*.

Radio-Frequency Allocations in Europe: Conference in Stockholm

THREE of the study groups of the International Radio Consultative Committee met in Stockholm during May 15–27; and these were followed by a European Broadcasting Conference during May 28–June 30. This Conference had been called to consider the assignment of very high frequencies (ultra-short wave-lengths) for sound and television broadcasting in Europe. The work of the Committee was of a technical nature, designed to establish the basis upon which a scheme of frequency-sharing could be devised. For this purpose, one of the study groups presented wave-propagation curves showing the field-strength likely to be obtained from transmitting stations at distances well beyond their normal service area. Another group had studied the discrimination which it is desirable to attain in order to avoid interference between television stations operating in the same frequency-channel. By a combination of these results, the geographical separation desirable between stations sharing the same frequency-band could be established. The Stockholm broadcasting conference

has produced an agreement on three plans for the assignment of frequencies to European broadcasting (including television) within the three bands 41–68, 87·5–100 and 174–216 Mc./s. The General Post Office, which is the responsible administration in Great Britain, has stated that the Conference accepted the assignments which the United Kingdom has made for the five high-power and five low-power television stations being established by the B.B.C. For the second band (87·5–100 Mc./s.) the British delegation was successful in securing alternative sets of frequencies for amplitude and for frequency modulation, respectively. The agreement was signed on behalf of the administrations of twenty-one of the thirty-one countries represented at the Conference.

Anatomical Nomenclature

An international meeting of anatomists was recently held in London to discuss a proposal to establish an agreed anatomical nomenclature. The first attempt to reach a similar agreement was the work of a small committee, predominantly German in constitution, which was convened by the German Anatomical Society at its Leipzig meeting in 1887. This committee devised a list of terms, now known as the BNA, which was adopted at a meeting in Basle in 1895. The BNA has been endorsed by a number of countries; but nevertheless is not an internationally approved scheme. In 1933 the Anatomical Society of Great Britain and Ireland approved an English revision, and a German revision was published in 1936. The recent London meeting agreed that any new international nomenclature should be based on the BNA, which it was hoped would require a minimum of change. It was also agreed that each country was at liberty to translate the official Latin terms of the BNA into its own vernacular for teaching purposes; but that, wherever possible, official Latin terms should be used in publications. The revision of the BNA is the responsibility of professional anatomists; but it was decided that it would be in the best interests of all if physiologists, pathologists, clinicians, and others concerned in the education of medical students, should communicate any views they might have about anatomical nomenclature to the committee. According to a recent letter to *The Lancet* (July 5, 1952), Prof. T. B. Johnston (Guy's Hospital, London, S.E.1) is undertaking the task of collating such proposals in Great Britain. The various sub-committees dealing with this matter hope to submit a report to the International Congress of Anatomists to be held in France in 1955.

History of Science

Last year the attention of readers of *Nature* was directed to the publication, by E. Munksgaard, of Copenhagen, of the first two numbers of *Centaurus*, a new quarterly devoted to the history of science and medicine (*Nature*, 167, 841). Three further numbers have since appeared, containing fifteen original articles on a variety of subjects of scientific, medical, biographical and bibliographical interest. Among these may be noted, in Vol. 1, No. 3, a critical article by Prof. Benjamin Farrington on Francis Bacon's "Temporis Partus Masculus", and, in the first number of Vol. 2, Prof. Edward Rosen, of New York, discusses when Galileo made his first telescope. Under the heading "Varia", in Vol. 1, No. 4, is a description of the recently established Belgian Museum for the History of Science, situated in Ghent. First planned in 1939, war delayed its opening until 1948. It was first housed in the Archæological Museum, but latterly was moved to more spacious accommodation in the Museum of Fine Arts. The Museum is stated to be especially rich in old medical and surgical instruments, a new acquisition being a collection of surgical instruments representative of ancient Egypt and the Middle East. Documents, both printed and manuscript, bearing on the history of the sciences also form part of the collections. Each number of *Centaurus* contains several book reviews and there are also extensive lists of books received. The high standard of printing and illustration is maintained, and this quarterly is one well worth the attention of British readers interested in the history of science and medicine.

Gamma-Ray Sources for Radiography

A committee of the Industrial Radiology Group of the Institute of Physics has recently prepared a "Memorandum on Gamma-Ray Sources for Radiography" (obtainable from the Institute; pp. 23; 1952; 3*s*. 6*d*.), which provides a brief statement of the physical characteristics of the gamma-ray sources for radiography by means of which a wide range of radiography can be carried out without X-ray equipment. In addition to the older, costly and somewhat rare, radium there are now available sources consisting of radon obtainable from the Radiochemical Centre, Amersham, and three artificial radioactive sources—cobalt-60, tantalum-182 and iridium-192—from the Atomic Energy Research Establishment, Harwell. Attention is directed in the memorandum to radiographic technique, protection of personnel and precautions to be taken when handling or transporting the sources, and to the cost of installation of the necessary equipment for gamma-radiography. Useful data sheets, summarizing essential information and obtainable from official sources, are included as an appendix to the memorandum. For example, cobalt-60, which has a half-life of 5·3 years and is recommended for the radiography of steel 2–6 in. thick, costs £40 approximately for the equivalent of 1 gm. of radium; the radium can be supplied on loan at a rental of £225 a year. The activity of radium remains sensibly constant with time whereas that of the other sources decreases; but the artificial sources can be returned to the atomic pile for reactivation. With regard to the technique of gamma-radiography, it is mentioned that the technique is simpler than that using X-rays, but the interpretation of the results is a skilled job. Though the radiographer must have an adequate knowledge of protection and must be a responsible person, his training need not be so broad in scope as that for X-radiography, since no high-voltage circuits are involved. Training facilities, though limited, are available in Great Britain, and particulars of these can be obtained from the Institute of Physics, 47 Belgrave Square, London, S.W.1.

Twenty Years of Work at the Jungfraujoch

The November 1951 issue of *L'Astronomie* contains a number of interesting articles, two of which are connected with the scientific station of Jungfraujoch, and are contributed by M. D. Chalonge, director of the station. The first of these refers to the celebration of the twentieth anniversary of the inauguration of the station in 1931, which took place on September 26 and 27, 1951, at Interlaken and afterwards at the Jungfraujoch itself. A short account is given of the

various activities of the station in the physics of cosmic rays, astrophysics and the physiology of high altitudes (laboratories have been installed for work in other fields as well). The initiative in the project is due to W. R. Hess, professor of physiology in the University of Zurich, who spent two years in the work of organization, interesting various institutions of other countries in the scheme, and obtaining the necessary financial support to carry it out. Several institutions have combined to endow the station with a small observatory specially well placed for research on spectroscopy and spectrophotometry in the infra-red and ultra-violet regions. The Observatory of Paris and the University of Paris, and also the Observatory of Uccle, have generously presented certain instruments to the station, and the Observatories of Geneva and Basle and the Institute of Astrophysics, Paris, have a scheme for mounting a 40-cm. Cassegrain telescope which will give astronomy an important place at the Jungfraujoch. The second article gives the results of ten years of astronomical observations and refers to the schemes for new research in various fields; it shows the intense keenness of the Director, and everyone will wish him great success in his programme. In concluding the article, he thanks all those who have contributed to the progress of the work, including a group of young students from the Universities of Basle and Zurich, some of whom are now teachers in different places. The list of publications, commencing in 1933, given at the end of the second article, shows the activities of the station and is very creditable to the Director and his staff.

Geography in the Secondary School

At the request of the Executive Committee of the Geographical Association, two of its members have prepared a memorandum on the teaching of geography in secondary schools and, particularly, in modern schools. No young people, they suggest, ought to leave school without the fullest and most understanding picture possible of the locality, the land, and the world in which they will begin to earn their living and live their adult lives. These young people should have some real appreciation of man's dependence in all parts of the world upon the land in which he lives; upon the warmth and moisture without which his crops cannot grow; upon natural resources that he employs to meet his needs, whether simple or complex; upon the essential and irreplaceable few inches of soil which sustain him in his many millions throughout the world. In a world where great distances no longer separate men as they once did, geographical knowledge forms the background essential to an understanding of international affairs and to an appreciation of the differences of outlook which still divide peoples from one another. To help the geography teacher, the writers of the memorandum devote considerable attention to the content and organization of the geography course, the study of geography out of doors, and the use of equipment, including maps. The memorandum has been well conceived and carefully prepared; copies may be obtained from the Geographical Association, c/o the Park Branch Library, Duke Street, Sheffield 2.

Use of Films in the University of Cambridge

The fifth report of the Cambridge University Educational Film Council indicates that, besides regular film sessions in the Department of Geography, weekly sessions of Russian sound films are now provided for students in the Department of Slavonic Studies during all terms. Considerable use is also made of the film for teaching in the Department of Zoology. An interesting development during the year was a further investigation on the use of 'silent' films in education which was carried out in the Department of Engineering. Although more experimental confirmation is required, the evidence provided by this investigation seems to show that, first, when members of an audience have been given the opportunity of comparing 'silent' films shown with and without musical accompaniment, their opinion of what has been the effect of the music on their attention is in general a reliable index of its actual effect, measured by tests made after the showing of the films; secondly, that more students are aided by accompaniment to silent educational films than are hindered; and, thirdly, that those who are aided are those most receptive to the visual film medium. Among the research films which have been made is that of the Cambridge Jotenheim Expedition showing glacier formations, and others on the fur seal of the Pribilof Islands and on the sea-urchin's eggs. The report also contains a complete list of all the films made in connexion with teaching or research at Cambridge.

Current Trends of Physics in the United States

The September issue of the *Journal of Scientific Instruments* (**28**, No. 9; 1951) contains, in addition to original contributions and other regular features, a special article by Dr. J. C. Overbeck, of the Northwestern University, Evanston, Ill., and is the latest in the series of articles which he has contributed at intervals during the past twelve years on experimental physics in the United States. In his illustrated article, Dr. Overbeck surveys, by selecting several topics from the papers published in American physics journals, the significant trends in the method and technique of experimental physics in the United States during the past two years. The topics chosen include the germanium phototransistor and the germanium rectifier; two new types of mass spectrometer, the one using a time-of-flight method and the other velocity selection; a diaphragm type of pressure gauge for very rapid transient pressures; a novel method of increasing the safe power input of an X-ray tube by twenty to twenty-five times but still retaining the sharp focal spot; photographing sound waves; and an ingenious method of magnifying a crystal layer to provide an image of its atoms. Dr. Overbeck considers the period under review to be one of development rather than of profound new discoveries.

Thirteenth International Horticultural Congress, London

The thirteenth International Horticultural Congress will be held in London during September 8–15 under the auspices of the Royal Horticultural Society. Three general lectures will be given on each of the following subjects: environment, soils and nutrition, plant breeding, and growth and development. In addition, about a hundred and forty lectures will be given at the meetings of the seven specialized sections, which are as follows: fruit growing, vegetable growing, ornamental plant growing, plant breeding, environmental control, seeds, and tropical and subtropical horticulture. The various meetings will be held in the halls of the Royal Horticultural Society, Vincent Square and Greycoat Street,

London, S.W.1, and at Church House, Dean's Yard, Westminster, London, S.W.1. Following the week of lectures, there will be tours and day excursions to research stations, gardens, nurseries, fruit- and seed-growing establishments, etc.; visits to places of historical interest will also be included. Other events that will take place during the Congress are as follows. The International Committee for Horticultural Congresses will meet on September 7 and 13; the International Committee on Horticultural Nomenclature and Registration will meet on September 7; a meeting of representatives of botanic gardens under the auspices of the International Botanic Gardens Commission will be held on September 13; and the Flower Show of the Royal Horticultural Society will take place during September 9–10. The membership fee for the Congress is 4 guineas. Further details can be obtained from the Secretary, Thirteenth International Horticultural Congress, Royal Horticultural Society, Vincent Square, London, S.W.1.

The Potsdam Geodetic Institute

FOLLOWING on the political changes in Germany resulting from the War, the Potsdam Geodetic Institute has renewed the publication of its work in a new series of *Veröffentlichungen*, of which six issues have been received, of dates 1949–51. They appear under the auspices of the Deutsche Akademie der Wissenschaften zu Berlin, of which the Geodetic Institute became in 1946 a dependent body, under the directorship of F. Mühlig. The Institute welcomes exchanges of its publications with those of other geodetic workers. The six issues now available deal partly with work begun before the War, as in the study (No. 2, F. Mühlig) of the 24-metre interference comparator, the construction of which was begun in 1937, and in No. 3 (K. Weiken), dealing with pendulum observations, 1934–43. Nos. 1 and 6, by K. Reicheneder, deal with the theory of errors and adjustment of networks in nadir triangulations; No. 4, by H. Haalck, is on gravity-disturbed fields and on the theory of the normal figure of the earth; and No. 5, by the late K. Friedrich and W. Jenne, discusses in much detail the solutions of systems of linear equations in which many coefficients are zero. The back covers of the later issues list some of the post-war publications of the Potsdam Geophysical Institute, prepared by R. Bock, F. Burmeister, F. Errulat, and W. Schumann; they deal entirely with geomagnetism.

Jodrell Bank Annals: A New Astronomical Journal

A NEW publication, to be known as the *Jodrell Bank Annals*, initiates Series 1 of the Astronomical Contributions from the University of Manchester (Vol. 1, No. 1, pp. 1–12; 1952). Through this medium a considerable amount of observational data will be made available to astronomers, especially in connexion with the continuous operation of the meteor, solar and galactic noise equipments at the Jodrell Bank Experimental Station. It is hoped, however, that the *Annals* will also contain, from time to time, contributions to theoretical astronomy from the University and its Mathematical Laboratory. The first publication, "Radio Echo Observations of the Daytime Meteor Streams in 1951", by G. S. Hawkins and Mary Almond, includes a certain amount of material that has previously appeared in *Mon. Not. Roy. Astro. Soc.* and also in *Nature*; but a few new features are worth attention. A new minor stream was detected near υ Piscium on May 12 and 13; but the radiant structure was diffuse. Although it is suggested that this stream may correspond to the Piscid streams observed in 1947 and 1948, the difference of 10° in the right ascension of the radiant renders the identification uncertain. The η Aquarid stream supplied meteors with velocities 63·7, 63·0 and 58·8 km./sec., respectively, as shown in Table 4; but meteors radiating from a radiant at R.A. 336°, Dec. 0°, with a period of Halley's Comet, should have a velocity of 70·4 km./sec. (velocities in all cases are geocentric), and the velocities indicated by the radio echo method correspond to a period of about ten years. This implies that the stream cannot be closely aligned with the orbit of Halley's Comet, nor could it be associated with the October Orionids. Some astronomers doubt very much the connexion of Halley's Comet with either stream—and in particular the Orionids—and hold that the apparent similarity in orbital elements is probably fortuitous. In *Mon. Not. Roy. Astro. Soc.*, **111**, 37 (1951), it was shown by Mary Almond that the ζ Perseids and the night-time S. Arietids on October 12, radiant at R.A. 38°, Dec. 12°, were probably associated, and the work of 1951 has reaffirmed the connexion. We can confidently anticipate many interesting items in this new publication.

British Library of Political and Economic Science

THE annual report for 1950–51 of the British Library of Political and Economic Science (pp. 22; London School of Economics, 1951) refers to restrictions on expenditure necessitated by the heavy expenditure of the previous year and the increased cost of books and periodicals, but acquisitions during the year brought the total of bound volumes to 323,575 as against 315,185 in 1950, of which 11,281 were in the lending library and 3,891 in the Shaw library. Expenditure on treatises was £4,187, as against £5,377 in 1949–50, and on periodicals £5,524 as against £3,711; and 6,707 periodicals were currently received as against 6,291 in the previous year. Treatises issued, however, fell from 44,969 to 37,669; but works lent to other libraries increased from 516 to 761, while research readers' permits increased from 452 to 482. Progress has been made with the preparation of the three further volumes of the "London Bibliography of the Social Sciences" which will cover the intake of the Library during 1936–50. A special grant permitted the clearing-off of most of the arrears of binding which had accumulated since the War, but extensions to the fabric had again to be postponed. A list of publications by members of the Library staff is appended.

British Mammals

THE Trustees of the British Museum (Natural History) have again put naturalists in their debt by the production of "A List of British Mammals" (2*s.* net). This has been written by T. C. S. Morrison-Scott who, after an explanatory account of how the scientific names of animals are devised, describes the use of certain keys to the external characters and skulls of those species which might confuse the layman. Among the mammals described are the hedgehog, mole, seven species of shrew, twelve species of bat, the fox, pine marten and three species of stoat, the weasel, two species of polecat, badger, otter, Scottish wild cat, seven species of deer, three species of hare, the rabbit, two species of dormouse, eighteen species of field mouse, the black and brown

rats, the house mouse, twenty-one voles and the coypu. Marine species include the grey and common seals and twenty-three species of whale, dolphin and porpoise. The descriptions are supplemented by a number of clear text-figures.

Medical Research Council Travelling Awards, 1952–53

THE Medical Research Council has announced the following travelling awards for the academic year 1952–53. *Rockefeller Travelling Fellowships in Medicine:* Dr. M. de Burgh Daly, lecturer in physiology, University College, London; Dr. J. E. Hotchin, member of the scientific staff, National Institute for Medical Research, London; Dr. E. L. McDonald, assistant to the professor of medicine, Middlesex Hospital, London; Dr. R. G. Mitchell, lecturer in child health, University of St. Andrews, Dundee; Dr. N. B. Myant, member of the scientific staff, Department of Clinical Research, University College Hospital Medical School, London; Dr. P. C. Reynell, graduate assistant, Nuffield Department of Clinical Medicine, Radcliffe Infirmary, Oxford. *Eli Lilly Travelling Fellowships in Medicine:* Dr. C. J. Earl, junior lecturer, Department of Chemical Pathology, Guy's Hospital Medical School, London; P. H. Schurr, senior registrar in neurosurgery, Radcliffe Infirmary, Oxford; Dr. R. G. White, Freedom research fellow, London Hospital; Dr. G. M. Wilson, senior lecturer in therapeutics, University of Sheffield, and assistant physician, Sheffield Royal Infirmary. *Dorothy Temple Cross Research Travelling Fellowships in Tuberculosis:* Dr. C. N. Iland, lecturer in bacteriology, University of Bristol; H. Platt, University research fellow in veterinary pathology, Department of Pathology, University of Liverpool. *Alexander Pigott Wernher Memorial Travelling Fellowships in Otology:* Dr. D. R. Haynes, Department of Otolaryngology, Johannesburg General Hospital; Dr. R. F. Naunton, member of the scientific staff, Wernher Research Unit on Deafness, Institute of Laryngology and Otology, Royal National Throat, Nose and Ear Hospital, London. *French Exchange Scholarships in Medical Science* (in association with the Centre National de la Recherche Scientifique): Dr. J. D. Carr, British Empire Cancer Campaign grantee, Poultry Research Centre, Edinburgh; Dr. M. A. Epstein, assistant pathologist (research), Bland Sutton Institute, Middlesex Hospital, London.

Merck Fellowship of the National Research Council, Ottawa

THREE post-doctorate research fellowships, endowed by Merck and Co., Ltd., have been awarded by the National Research Council, Ottawa. The awards, which total 10,500 dollars and travel allowances, with an extra 500 dollars to each institution concerned in order to help pay for specialized equipment, have been made to the following for research as indicated: Dr. S. G. A. Alivisatos (University of Athens and McGill University), enzyme systems, at Bellevue Medical Center, New York City, under Dr. S. Ochoa; Dr. K. K. Carroll (Universities of New Brunswick, Toronto and Western Ontario), factors affecting the hatching of potato eelworms, at the University of Cambridge under Prof. A. R. Todd; and Dr. R. L. Kay (University of Toronto), properties of electrolytic solutions, at the Rockefeller Institute for Medical Research under Dr. D. MacInnes.

"Index of Zoologists"

THE Zoological Section of the International Union of Biological Sciences is engaged on the preparation of an "Index of Zoologists". This will give the addresses, ages and special interests of zoologists throughout the world. The work is well advanced and it is much hoped that it will be published before the International Zoological Congress in July 1953 at Copenhagen. Its completion is, however, delayed by the fact that many zoologists have failed to fill in and return the questionnaire postcard which they received. They are now requested by the Union to complete and return their cards to M. Marc André, 61 rue de Buffon, Paris 5e. If the card has been lost, another can be supplied.

Announcements

THIS year the Australian and New Zealand Association for the Advancement of Science will meet in Sydney during August 20–27. The president will be Sir Douglas Berry Copland, vice-chancellor of the Australian National University at Canberra. The title of his address will be "Authority and Social Control in a Free Society".

MR. COLIN G. CLARK, recently Under-Secretary of State for Labour and Industry and financial adviser to the Treasury, Queensland, has been appointed director of the Institute for Research in Agricultural Economics at Oxford, in succession to Mr. A. W. Ashby, who is retiring under the age-limit provisions.

A DISCUSSION on "Biology as a Career" is being held in Birmingham on October 4 under the auspices of the Institute of Biology. Speakers will include W. P. Yapp, Prof. J. F. Danielli, B. G. Meara, Sir Harold Himsworth, Dr. H. J. Bunker, Dr. W. E. Ripper, G. A. C. Herklots and Sir William Slater. Further information can be obtained from the General Secretary, Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1.

THE Division of Medicine and Public Health of the Rockefeller Foundation is providing bursaries for postgraduate study and research in public health engineering in universities in the United Kingdom, and for the next three years these will be administered by the Institution of Civil Engineers. Each bursary will be worth approximately £450 and will normally be tenable for one year, and candidates must hold a suitable engineering degree of a university within the British Commonwealth. Application forms (to be completed by August 31) and further information can be obtained from the Secretary of the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1.

A FELLOWSHIP in any branch of natural science and others in industrial research, virology and agriculture, each worth £A1,000, are being offered by the British Memorial Fund established in Victoria, Australia. The fellowships provide for ten months of study in Victoria and cover all travelling and living expenses during the period. Wives and children are welcomed; but no extra expenses can be paid to cover them. Applicants aged between 25 and 35 and of either sex are eligible, provided they are of British stock with ten years residence in the United Kingdom. Further details can be obtained from Sir John Lienhop, Victoria House, Strand, London, W.C.2, to whom applications should be made immediately.

BIOLOGICAL ACTIVITY OF COMPLEX IONS

By Dr. F. P. DWYER and Dr. ELEONORA C. GYARFAS
Department of Chemistry, University of Sydney, N.S.W.
AND
Dr. W. P. ROGERS and Dr. JUDITH H. KOCH
Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, McMaster Laboratory, Sydney, N.S.W.

FOLLOWING the suggestion of Dwyer *et al.*[1], the biological activity of a number of complex ions has been examined. The toxicity of these compounds to mice, their bacteriostatic and bacteriocidal properties and their actions on enzymes have been studied.

Toxicity to mice. The compounds were dissolved in saline and given by intraperitoneal injection. Unless stated otherwise, the results are given in the table as the approximate minimum lethal dose. Owing to the difficulty of obtaining large amounts of the compounds, accurate L.D.50 values were not obtained. The figures are, however, sufficient to indicate the degree of toxicity.

Asymmetric Complex Ions*

Compound	Optical form and toxic dose
Tris-ethylenediamine cobalt III nitrate, $Co(en)_3(NO_3)_3$ (ref. 6)	(+), (−) and (±), 165 mgm./kgm.
Tris-1 : 10-phenanthroline ruthenium II perchlorate, $Ru(phenan)_3(ClO_4)_2$ (ref. 7)	(+), 9·2; (−), > 18·4 mgm./kgm.
Tris-1 : 10-phenanthroline nickel perchlorate, $Ni(phenan)_3(ClO_4)_2$ (ref. 8)	(+), 5·8; (−), > 11·6 mgm./kgm.
Tris-1 : 10-phenanthroline iron II perchlorate (ref. 9)	(±), 14·2 mgm./kgm.†
Tris-2 : 2′-dipyridyl osmium II perchlorate, $Os(dipy)_3(ClO_4)_2$ (ref. 10)	(+) and (−), between 13·5 and 14·8 mgm./kgm.
Tris-2 : 2′-dipyridyl ruthenium II iodide (ref. 11)	(+) and (−), between 15·7 and 16·8 mgm./kgm.
1 : 10-bis(salicylideneamino)-4 : 7-dithiadecane cobalt III iodide, Co(TET)I (ref. 12)	(+) and (−), between 85 and 95 mgm./kgm.
1 : 8-bis(salicylideneamino)-3 : 6-dithiaoctane cobalt III chloride, Co(EEE)Cl (ref. 13)	(+) and (−), between 210 and 220 mgm./kgm.

* (+) and (−) refer to sign of rotation in either the Na_D line or Hg_{4461} line.
† The active forms racemized rapidly at 37° C.

Complex Ions

Compound	Toxic dose
Bis-2 : 2′ : 2″-terpyridylruthenium III perchlorate, $Ru(trpy)_2(ClO_4)_3$ (ref. 14)	> 3 mgm./kgm.
Bis-2 : 2′ : 2″-terpyridylruthenium II iodide, $Ru(trpy)_2I_2$	> 3 mgm./kgm.

Neutral Complexes

Compound	Optical form and toxic dose
Tris-acetylacetane cobalt III*	(±), > 75 mgm./kgm.
Tris-glycine cobalt III	(±), > 150 mgm./kgm.

* First dissolved in alcohol, then diluted with saline

As a rule, with the phenanthroline compounds the addition of the (−) form to the (+) form delayed the time of death slightly. The toxicity of the (+) and (−) forms was approximately additive.

The compounds $Ru(phenan)_3(ClO_4)_2$, $Os(dipy)_3(ClO_4)_2$ and $Ru(trpy)_2I_2$ were given *per os* to mice. The largest doses used, which were five times the toxic intraperitoneal dose, had no effect. The fæces of the mice showed the characteristic colours of the compounds, which appeared to have passed through the alimentary tract unchanged.

Toxic intraperitoneal doses of all of the compounds except the sexadentate chelate compounds, Co(TET)I, Co(EEE)Cl, and the uncharged complexes caused death in 10–15 min. About 1½ min. after dosing, breathing became laboured and then spasmodic. The hind limbs appeared paralysed and then tonicoclonic spasms occurred. Death appeared to be caused by respiratory failure. Atropine potentiated the toxic action of the (+) and (−) forms.

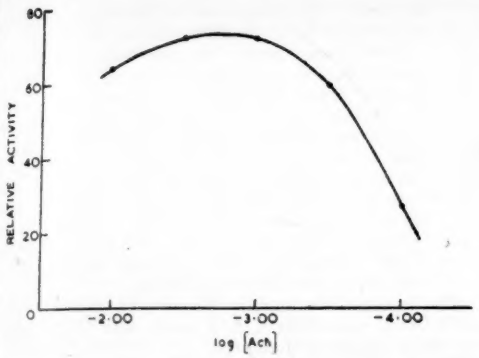
Action on enzymes. The toxic effects of the compounds on the mice suggested that the action of cholinesterase might have been affected, and this enzyme was therefore selected for examination. The enzyme was prepared from the erythrocytes of sheep by a modification of the method of Mendel and Rudney[2]. Activity was estimated manometrically in bicarbonate – carbon dioxide buffer. The compounds were in contact with the enzyme for about fifteen minutes during equilibration; after tipping in the substrate, inhibition was measured over a period of 30 min. It was found that the metal complexes of phenanthroline, dipyridyl and terpyridyl were potent inhibitors of cholinesterase. With a substrate of 0·06 *M* acetylcholine, $Ru(phenan)_3(ClO_4)_2$, 10^{-5} *M*, gave an inhibition of about 80 per cent. The difference between the (−) and (+) forms of the dipyridyl complex was pronounced. At 10^{-4} *M* the (−) form gave about 90 per cent inhibition. The (+) form at the same concentration gave about 20 per cent inhibition; at 10^{-3} *M* the inhibition reached about 75 per cent. The inhibition caused by all of these compounds seemed to be competitive (see graph). No appreciable inhibition was noted with $Co(en)_3(NO_3)_3$.

The use of (±) mixtures of $Ru(phenan)_3(ClO_4)_2$ did not appreciably affect the nature of the inhibition. It appeared that the action of the (−) and (+) forms was additive, and the (+) form did not appreciably antagonize the (−) form.

The action of the complexes on crystalline aldolase prepared by the method of Taylor and Green[3] was examined. Even at high concentrations no inhibition was noted.

Action on bacteria. Concentrated aqueous solutions of the optically active complex salts were sterilized by intermittent heating at 60° C. Appropriate amounts were added to sterile Wright's broth and their effects on the growth of *Escherichia coli*, *Staphylococcus hæmolyticus* and *Salmonella typhi-murium* were examined. With (+), (−) and (±) Co(TET)I, bacteriostatic and sometimes bacteriocidal action at 1/1,000 was noted against *E. coli* and *S. hæmolyticus*. In some instances, the growth of the Gram-positive organisms was inhibited at concentrations of 1/1,000 by (+), (−) and (±) $Ru(phenan)_3(ClO_4)_2$.

Discussion. The neutral complexes examined had no overall charge and had no pronounced biological



activity. The complex cations, most of which showed a high biological activity, were chemically highly stable, co-ordinately saturated, and had no specific active groups or centres. The ruthenium and osmium complexes were not attacked by concentrated acids or alkalis. Dissociation of the complexes could be regarded as extremely small. It may be concluded from the similarity of the effect in each series of compounds that the biological activity was a function of the cation as a whole and not of the metallic atom.

From the concept of the "essential neutrality of atoms" (Pauling[4]), it may be postulated that the ionic charge is not centred in the metallic atoms, but is distributed fractionally over the ligands. The complex cations thus carried a peripheral charge, which was related to the total charge, to the electropositivity of the metal atom, the electrophyllic properties of the ligands, and probably to their size. They thus partake more of the nature of organic compounds than of simple ions, but differ in that the charge is not localized and is greater in magnitude. With the exception of the $Ru(trpy)_2^{++}$ ion, they exist in enantiomeric forms in which the charge distribution leads to non-superimposable mirror-image electrical forms[1].

As a result of the nature of the metal/ligand bonds, charge separation may occur in neutral complexes, which consequently carry a small peripheral charge[5].

It appears that the inhibition of cholinesterase occurred by adsorption-electrical interaction on an active centre sufficiently close to the ester-splitting centre to inhibit by a steric effect. The absorption centre appeared to be associated with an optically active carbon atom which had an asymmetric field due to the arrangement of four different dipoles. There was thus a general adsorption due largely to the cationic charge; and superimposed, a specific effect due to differential coupling of the asymmetric fields.

Inhibition by the $Ru(trpy)_2^{++}$ ion, it appears, was due to the charge alone; but the asymmetry of the fields was important in determining the degree of inhibition by the (+) and (−) forms of the tris-2:2′-dipyridyl complexes. It is not clear what factors influence the magnitude of the specific coupling. However, it is pertinent to point out that probably undue emphasis has been placed hitherto on the purely spatial considerations of optical antipodes, properties which appear to be incidental to the electrical properties.

The toxicity of the complexes in mice would depend upon the rate of penetration to the site of action and to the specific inhibitory actions at that site. The rate of penetration would depend partly upon the lipid/water partition, and partly upon the nature and configuration of the charge of the complexes. The results suggest that the (+) forms penetrated more rapidly than the (−) forms. The specific action, probably due to the inhibition of cholinesterase in the central nervous system, was also dependent upon the nature and configuration of the charge, (−) forms being more effective than (+) forms.

We are indebted to Mr. G. Merritt, of the McMaster Laboratory, who carried out the bacteriological work, and to the Trustees of the Ian McMaster Bequest for a grant to cover the costs of this investigation.

[March 10.

[1] Dwyer, F. P., Gyarfas, E. C., and O'Dwyer, M. F., *Nature*, **167**, 1036 (1950).
[2] Mendel, B., and Rudney, H., *Biochem. J.*, **37**, 63 (1943).
[3] Taylor, J. F., Green, A. A., and Cori, G. T., *J. Biol. Chem.*, **173**, 591 (1948).
[4] Pauling, L., *J. Chem. Soc.*, 1461 (1948).
[5] Dwyer, F. P., and Gyarfas, E. C., *Nature*, **163**, 29 (1951).
[6] Werner, A., *Ber.*, **45**, 121 (1912).
[7] Dwyer, F. P., and Gyarfas, E. C., *J. Proc. Roy. Soc. N.S.W.*, **83**, 170 (1949).
[8] Dwyer, F. P., and Gyarfas, E. C., *J. Proc. Roy. Soc. N.S.W.*, **83**, 232 (1949).
[9] Dwyer, F. P., and Gyarfas, E. C., *J. Proc. Roy. Soc. N.S.W.*, **83**, 364 (1949).
[10] Burstall, F. H., Dwyer, F. P., and Gyarfas, E. C., *J. Chem. Soc.*, 953 (1950).
[11] Burstall, F. H., *J. Chem. Soc.*, 172 (1936).
[12] Dwyer, F. P., Gill, N. S., Gyarfas, E. C., and Lions, F., *J. Amer. Chem. Soc.* (in the press).
[13] Dwyer, F. P., and Lions, F., *J. Amer. Chem. Soc.*, **72**, 1545 (1950).
[14] Morgan, G. T., and Burstall, F. H., *J. Chem. Soc.*, 1649 (1937).

RADIO OBSERVATIONS OF THE SOLAR ECLIPSES OF SEPTEMBER 1, 1951, AND FEBRUARY 25, 1952

By J.-F. DENISSE
Institut des Hautes Études, Dakar
AND
E. J. BLUM and J.-L. STEINBERG
École Normale Supérieure, Paris, 5e

THE radioastronomy research group working in the Physics Laboratory of the École Normale Supérieure in Paris organized an expedition to observe the annular solar eclipse on September 1, 1951. The totality zone crossed French West Africa and also the Niger near the Markala Dam (lat. 13° 42′ N., long. 6° 04′ W.), which had been chosen as the centre of observation.

The programme consisted of measurements on 9,350 Mc./s. (λ, 3·2 cm.) and 160 Mc./s. (λ, 1·78 m.). The aims were:

(*a*) On the centimetre wave-length: to compare total eclipse measurements made by Hagen, Haddock and Reber[1] in 1950 with annular eclipse observations; such a comparison may prove to be interesting for limb-brightening studies.

(*b*) On the metre wave-length: to study the dimensions of the radio-sun and the brightness distribution across the disk, taking advantage of the present low level of solar activity.

The meteorological conditions were favourable, the local conditions as to interference-level, mains-stability, auxiliary personnel and workshops were excellent and the solar situation was remarkably stable (very few prominences and two sunspots of slight importance).

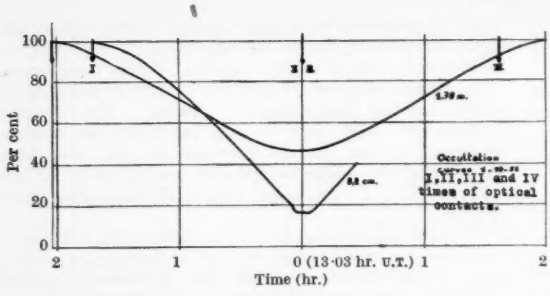


Fig. 1

The results obtained[2] were as follows (Fig. 1):

On the 3·2-cm. wave-length, errors of direction occurred which prevented us from using more than two-thirds of the eclipse duration. We observed that, at the time of eclipse maximum, 16 per cent of the whole radiation remained. This figure may be compared with those obtained by Hagen, Haddock and Reber, namely, 5·6 per cent for an eclipse of magnitude 1·018 against 0·975 in 1951. The disk fraction of area 8·6 per cent which was hidden in 1950 and could be seen in 1951 contributed 10–12 per cent to the total radiation. The theoretical figure is 12 per cent if limb brightening is assumed.

On the other hand, a disk of uniform brightness which would give the same 16 per cent remainder would have a radius of 1·07 that of the sun. The observed occultation curve always lies below the theoretical one computed for a disk of uniform brightness of radius 1·07 that of the sun. This also confirms the existence of limb brightening.

The occultation of a sunspot group is visible on the record. This allows us to see that the 3-cm. emitting area located near this group occupies the same position; its area is certainly smaller than twice the area of the perturbed zone.

On the 1·78-m. wave-length, the occultation curve obtained is the first published on a metre wave-length in a period of solar radio quietness. The relative accuracy achieved is 0·3 per cent. It can be observed that: (*a*) the decrease of the radio radiation begins 16 min. before the first optical contact. The apparent diameter of the radio-sun is 1·35 times larger than the optical apparent diameter; (*b*) at the contact times, 8·5 per cent of the total radiation is occulted; (*c*) at the time of maximum eclipse, 48 per cent of the total radiation remains.

From these results, we may deduce that the solar radiation on 1·78 m. wave-length does not possess radial symmetry. If we study the occultation curve for a disk with uniform brightness distribution with a radius 1·35 times that of the sun, we find that 70 per cent of the total radiation must remain at maximum eclipse. On the other hand, the energy received actually decreases much more rapidly near optical contacts than for any other model with radial symmetry, with uniform brightness or with limb or centre brightening.

The equatorial apparent diameter of the radio-sun on 1·78-m. wave-length is a great deal larger than the polar apparent diameter.

These results have been wholly confirmed by the observation of the eclipse of February 25, 1952, at Marcoussis (near Paris) and Dakar (French West Africa), where the apparatus used at Markala in 1951 is now daily operated. Fig. 2 shows that, at the time of optical contacts, a decrease of 0–1 per cent was observed in Paris in 1952, 8·5 per cent in Makala in 1951 and 12–13 per cent in Dakar in 1952. These figures confirm the above results. A tentative model of the radio-sun observed on a wave-length of 1·78 m. is also given in Fig. 2.

A detailed description of these experiments will shortly appear in the *Annales d'Astrophysique*. The description of the apparatus will appear in another memoir.

We wish to acknowledge the help of Prof. Y. Rocard, director of this Laboratory, and to thank the Service des Études et Recherches, French Navy Department, the Bureau des Longitudes and especially the staff of the Office du Niger establishments in Markala (French West Africa). [May 19.

[1] Hagen, J. P., Haddock, F. T., and Reber, G., *Sky and Telescope*, **10**, 5 (1951).

[2] Bosson, F., Blum, E. J., Denisse, J.-F., Leroux, E., and Steinberg, J.-L., *C.R. Acad. Sci., Paris*, **233**, 917 (1951).

[3] Blum, E. J., Denisse, J.-F., and Steinberg, J.-L., *C.R. Acad. Sci., Paris*, **234**, 1597 (1952).

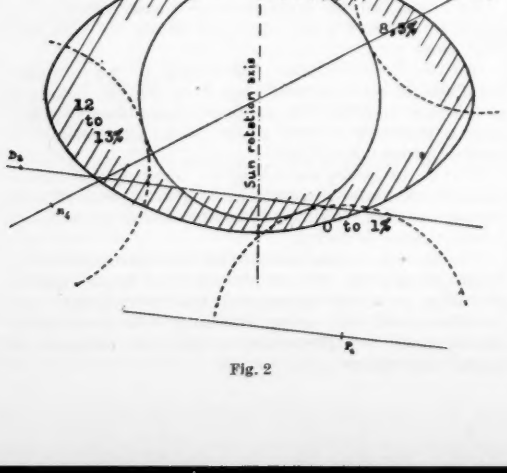


Fig. 2

MEASUREMENT AND INTERPRETATION OF EYE-DOMINANCE

By MARGARET M. CLARK
Education Department, University of Glasgow

SUCH expressions as 'the dominant eye' or 'the master eye' are commonly used; but the meaning attached to the terms varies considerably. There is, further, no agreement as to the precise significance and importance of such a conception as dominance in eyedness. At one extreme are those who agree with Gould[1] in believing that right-handedness follows generally more perfect development of the right eye; or Parson[2], who stated that eyedness is one aspect of dominant sidedness and due to greater activity of the cerebral hemisphere which governs the favoured side. There are also those who claim that there is no such thing as a unitary factor of eye-dominance; that it is only evident under the artificial conditions of a laboratory experiment, and even there, probably an artefact.

When one considers what is meant by the actual term eye-dominance, apart from its real signifi-

cance, here also there is considerable confusion. By the dominant eye can be meant either the eye with the greater visual acuity, that is, which can actually see better; or the preferred eye, which is not necessarily the same as the former. Matters are still further complicated by the fact that, whereas in handedness most important actions are carried out with one hand only and require a certain amount of skill, resulting in the choice of the same hand at each attempt, in eyedness, on the contrary, the normal method of using the eyes is as 'a pair of structures'. Thus dominance can either be considered when only one eye is being used, or in binocular vision, where in fixating or sighting one eye plays the leading part. All these points have to be borne in mind when constructing tests of eyedness or estimating the significance of such studies, especially where a claim is made that they reveal once and for all the dominant sidedness of the subjects.

In spite of the fact that binocular vision is the normal type, some investigators have used tests to determine the preferred eye for sighting where a deliberate choice of one eye is made. Examples of such tests are: sighting through a narrow tube, looking through a small hole, etc. The type of situation in everyday life when such a choice is made is in shooting with a rifle or using a microscope. Care requires to be taken in such tests to eliminate the effect of the dominant hand on the results. It appears that in instances where a high correlation was obtained between handedness and eyedness this was due to taking inadequate precautions to ensure that the preferred hand did not affect the results. When that precaution is taken, the correlation between handedness and eyedness is low. In early studies of eyedness, visual acuity was sometimes the only measure used. It has since been pointed out by several investigators that comparative visual acuity should not be confused with the dominant eye. Further, it has been shown by Gahagan[3] that in only 55 per cent of his cases was the better eye the preferred one.

It is not evident under normal conditions that one eye is dominant when both appear to be working. Some of the tests designed to determine the dominant eye in binocular vision are such that the subject has both eyes open, and is under the impression that he is using both; but the situation is such that it necessitates the use of only one. Examples of such tests are: sighting through a cone placed over both eyes, or through a small hole in a sheet of paper held at arm's length. If the subject looks directly at the experimenter, then the eye seen through the end of the cone or the hole in the paper is the dominant one. The advantage of using such a test is that the experimenter does not have to rely on the subject's report, which is obviously an advantage, especially in testing children. The use of such a simple technique means also that it has been possible to test children for eyedness at an early age, in fact as early as three years of age; and the eye preference then shown was found to be unchanged at the age of seven. Many more elaborate types of apparatus have been designed to measure eye dominance; but it appears that the simpler methods are as effective. Jasper and Raney[4], for example, utilized the 'phi phenomenon' as the basis for a test, while others have used retinal rivalry as a measure, by employing a stereoscope and presenting a different view to each eye, dominance being determined by the view which is kept longer in consciousness.

A warning which has been given by Crider[5] should be borne in mind. He carried out an investigation to discover the cause of the wide variation in figures found in different studies of eyedness, and claimed that this was due to the different criterion set up by different investigators. Consequently the data of no two investigators are comparable unless the number of sighting opportunities and the criterion are stated, and are in accord. This caution is particularly necessary when considering the figures given for indecisive eyedness.

Crossed laterality is the term used when a person's dominant eye and hand are not on the same side. Many have suggested that the ideal is for these to be in accord, claiming that this facilitates the co-ordination of skilled movements. Starting from the assumption that this is not only the ideal but also the normal, they have explained away cases of crossed laterality as being caused by change of handedness. A consideration of the facts reveals the inadequacy of this explanation. If, as is found, the percentages of right- and left-eyedness are 65 and 35 approximately, while those of handedness are about 94 and 6 respectively, then obviously a considerable number of right-handed people must be left-eyed. In short, the proportion of uncrossed to crossed laterals must be about 2 : 1. It seems absurd in any case to assume that all changed left-handers were left-eyed in the first instance; on the contrary, it would be more feasible to suggest that they may owe their success in making the necessary shift to the fact that they were already right-dominant in one respect, namely, eyedness. A third objection to this view, that crossed laterality results from changed handedness, is the fact that it does not suddenly appear after the children start school, but is also found in pre-school children. To have established that it may be normal to have the dominant hand and eye on opposite sides does not mean that one can dismiss the possibility that it may be advantageous to have them in accord, and that various difficulties may be encountered by those who are right-handed and left-eyed or left-handed and right-eyed. A number of writers have actually suggested that this does bring with it considerable educational difficulties, or even that left-eyedness may itself be an educational handicap. Further investigation is, however, needed on these points. A recent study[6] of the handedness of American top-flight baseball players showed that more than the expected number were left-handed, which leads one to consider the possible findings of an analysis of, say, ace dart players, archers, or crack shots with a rifle, in all of which sports hand–eye co-ordination is so important. It is possible that one would find among them a higher incidence of consistency with regard to hand and eye dominance, that is, more right-handed and right-eyed and left-handed and left-eyed than is found in a random sample of the population. This is an interesting idea, since it is usually said that a person's dominant eye cannot be changed. It would then reveal that the difficulties in learning to fire a rifle may not all be in connexion with handedness; in fact, these may be the least of the trouble. It might be advantageous for a left-eyed person to fire from the left shoulder, while a right-eyed person should fire from the right.

However, to leave the realms of speculation, it appears that dominance of one eye has been established roughly in the proportion of two right-eyed to each one left-eyed, and that it is found in its clearest form in binocular vision—that, in fact, true

binocular vision in the sense of identical functioning of the two eyes does not exist. Walls[7] has recently suggested an explanation of eye-dominance by what he termed his theory of directional dominance, claiming that the record of the innervations to the muscles of one eye only are used for the construction of binocular percepts of visual direction. This does not mean that the other eye is unused, but merely implies a differentiation in function of the two eyes. Walls mentioned the fact that after practice the microscopist is able to keep both eyes open without distracting his attention from the slide. If he should, however, attempt to use the other eye, the non-dominant, he will find that the contents of the field of view of the dominant eye are seen superimposed on the instrumental field, and seem to interfere with good observation of the slide. It appears that the benefit of eye-dominance is that it clears the visual field by giving the right of way to the image of one eye, the dominant, making it appear more substantial than the other, which tends to be suppressed.

This survey of the commonest types of eyedness and some interpretation of the phenomenon reveals at least the range of factors considered important by different investigators, and also the necessity for caution in the acceptance of the findings based on such tests. In spite of this, it must be maintained that the dominant eye is a reality, though some of the statements on the subject have been rash, and many of the findings of dubious validity.

[May 16.

[1] Gould, G. M., "Righthandedness and Lefthandedness" (Lippincott, 1908).
[2] Parson, B. S., "Lefthandedness—A New Interpretation" (Macmillan Co., 1924).
[3] Gahagan, L., *J. Gen. Psychol.*, **9**, 455 (1933).
[4] Jasper, H. H., and Raney, E. T., *Amer. J. Psychol.*, **49**, 450 (1937).
[5] Crider, B., *Child Development*, **6**, No. 2, 163 (1935).
[6] Lehman, H. C., and Webb, F. E., *Motor Skills Research Exchange*, **3**, No. 1 (1951).
[7] Walls, G. L., *A.M.A. Arch. Ophthalmol.*, **45**, No. 4, 387 (1951).

RADIATION CHEMISTRY

THE Faraday Society held a general discussion on "Radiation Chemistry" in the University of Leeds during April 8–10. The meetings were well attended and there were many visitors from overseas —forty-four from fourteen different countries— including many well-known workers in this field, among whom was Prof. K. F. Bonhoeffer, president of the Deutsche Bunsen-Gesellschaft für physikalische Chemie. The president of the Society, Sir Charles Goodeve, took the chair on the first day; on subsequent days Profs. C. E. H. Bawn and H. J. Emeléus presided. The authors were allowed five minutes to make the salient points of their contributions, so that ample time was left for discussion.

Radiation chemistry—the study of the chemical effects of photons, electrons, or positive ions of an energy greater than 50 eV.—has made rapid progress during the past few years, mainly owing to our increased knowledge of the chemistry of free radicals and of molecular ions. Its relatively slow development compared with that of photochemistry is due to the greater complexity of the primary process: in photochemical reactions this is simple and involves the absorption of a quantum of radiation by a molecule; but the transfer of energy from short wave-length radiation or from bombarding particles is complex, and prediction of the mechanism or of the products is uncertain. The object of this discussion, the first to be held on the subject by the Faraday Society, was to review the present position, to attempt a synthesis of the differing points of view of physicists, chemists and biologists, and to suggest further lines of development.

The general introduction was given by Prof. F. S. Dainton (Leeds), who reviewed the present difficulties of the subject and directed attention to the more important problems which have to be solved. He emphasized the lack of knowledge of the nature of the primary process; the value of the energy (W) required for the formation of an ion pair (formed along or near the track of the bombarding particle) is not known for liquids, nor how it is related to the ionization potentials of molecules with which the impinging particle collides. The relation of the mean ion density to the energy, mass and atomic number of the particles is, however, known qualitatively at least, and forms the basis of hypotheses which relate the amount and nature of the reaction product with the mass and energy of the particle. Caution must be observed in applying to liquid systems conclusions based on the gaseous phase; but cases are known in which such extrapolations are legitimate. In polar media, however, the magnitudes of solvation energies and entropies are such as to invalidate the assumption of parallel behaviour in the liquid and the vapour, and they refer to equilibrium conditions not relevant in systems in which the charge transfer processes are very rapid. Prof. Dainton directed attention to some important questions which would be discussed at the meeting: the observed value of G_R, the fraction of the absorbed energy used in the formation of radicals, may be a function of the solute and may depend on other competing processes, and thus the maximum observed values are likely to be the more significant; differences in track density leading to variations in ionic yield may arise from quite small changes of energy—a point of considerable importance to radiobiologists; although the initial distribution of primary products is non-uniform, rate expressions based on uniform distribution may successfully account for the observed kinetic behaviour; the radiolysis of water produces species which may lead either to the oxidation or the reduction of certain solutes, and a considerable knowledge of the behaviour of the system under varying conditions is necessary before theoretical conclusions are made; the concept of protection and sensitization in biological systems may be of importance in simpler systems.

The first three papers were on the primary act. Prof. F. W. Spiers (Leeds) reviewed the processes of absorption of ionizing radiations in terms of the quantum energy, and discussed the relative importance of the photoelectric, Compton recoil and the pair-production processes in the absorption coefficient of water. (Data for water for some commonly used radiations were given.) The loss of energy by charged particles was discussed in terms of the stopping power of the medium given by the theory of Bethe and its modifications. The magnitude of the energy (W) required to produce an ion pair was discussed in relation to the type of particle, its speed and the properties of the absorbing medium, and finally some indication was given of the distribution of ion pairs along the track of the fast-moving particle. Prof. H. S. W. Massey (London) dealt with the nature of gaseous ions, and the formation of clusters by alkali metal ions with polar molecules and with rare gas

atoms, and described recent work on the molecular ions of the rare gases. He directed attention to certain features of atomic and molecular negative ions and to metastable ionic states. The second part of his paper was concerned with the rates of reactions involving ions, their classification, and the different processes which may occur. Prof. J. L. Magee (Notre Dame) examined the mechanism of charge neutralization in reactions between positive and negative ions by means of potential energy curves and their crossing-points, and gave a theory of the probability of transition. He concluded that the reactants retain their constituent atoms and configurations, and that dissociation may follow, but not rearrangements involving both the ions; highly excited states are to be expected, and radicals should be common reaction products. In the discussion which followed, some consideration was given to the problem of light emission and its role (if any) in radiation chemistry.

The next group of papers were devoted to actinometry. Dr. N. Miller and J. Wilkinson (Edinburgh) compared and criticized a number of systems which have recently been proposed for chemical dosimetry. They discussed the characteristics of suitable reactions in aqueous media, and summarized the pertinent data for the oxidation of ferrous ions in air-saturated 0·8 *N* sulphuric acid solutions, the reduction of ceric ions in similar solutions, and the hydroxylation of benzene in air-saturated water. There is considerable lack of agreement, except for ferrous sulphate solutions at lower dose-rates. The results were presented of their exhaustive tests designed to examine the variables which might cause irreproducibility in this system with X- and with γ-rays. The system is also applicable to electron dosimetry, but not to that of heavy particles. Non-aqueous systems were also discussed. Prof. F. S. Dainton, in his introductory remarks, expressed the gratitude of the meeting to Dr. Miller and Mr. Wilkinson, and hoped that it would be generally agreed to use the aerated ferrous sulphate actinometer for X- and γ-rays with dose-rates less than 1,000 r./min. Prof. Milton Burton (Notre Dame) strongly supported this view, and stressed the desirability of recording the total amount of chemical change per unit of energy absorbed (for example, as the so-called *G*-value or radiation yield per 100 eV.) rather than the ionic yield. J. Wright (Harwell) described experiments on the pile irradiation of various chemical systems, designed so that they could be related to calorimetric measurements, which will ultimately be the basis of dosimetry for pile radiation chemistry. It was found that the ferrous sulphate system was suitable for short irradiations and gave information about the γ-radiation resulting from the decay of fission products. General discussion followed, devoted partly to a consideration of post-irradiation effects in the ferrous sulphate system.

Attention was then directed to the radiolysis of pure liquids. Prof. Burton and S. Gordon (Notre Dame) discussed the use of mass-spectrometric and radiation-chemical data on the same compounds for the interpretation of their mechanism of decomposition; the ions revealed by the former process are complementary to the radicals of the latter. The application of these methods to the radiolysis of benzene and heavy benzene (C_6D_6) shows that decomposition may occur either by bond rupture or by rearrangement; in a mixture the two compounds protect each other against radiation. A. Prevost-Bernas, A. Chapiro, C. Cousin, V. Landler and M. Magat (Paris) reviewed the possibilities and the limitations of two methods they have used for the determination of the number of free radicals formed in organic liquids by ionizing radiations, and gave estimates of the fraction of the energy used in free radical formation. They also discussed the mechanism of the production of free radicals in liquids irradiated in a pile, and the contributions of the different radiations present.

The radiolysis of water is important not only for its own sake but also because it is a factor in the study of the radiation chemistry of aqueous solutions. Dr. A. O. Allen (New York) discussed his mechanism of the decomposition of water, based on the very large amount of experimental work done in his laboratories during the past five years, according to which molecular hydrogen and hydrogen peroxide are formed simultaneously with the production of hydrogen atoms and hydroxyl radicals, the molecular yield increasing, and the radical yield decreasing, with the ionization density of the radiation. The reverse reaction, $H_2 + H_2O_2 \rightarrow 2H_2O$, which is initiated by free radicals, is favoured by dissolved hydrogen and retarded by dissolved oxygen or hydrogen peroxide. The molecular decomposition is ascribed to reactions occurring in very small regions —hot spots. Dr. Allen also discussed the conditions to be satisfied in experiments designed to determine the molecular (G_M) and radical (G_R) radiation yields in water, and gave provisional values for these quantities which were the subject of some discussion. Prof. P. Bonet-Maury (Paris) also discussed the formation of hydrogen peroxide and of hydrogen from pure water by radiations of different types, and the possible secondary reactions and equilibria which may occur.

The next group of papers was on the radiation chemistry of aqueous solutions. Dr. M. Haissinsky (Paris) considered the mechanism in dilute solutions in terms of the oxygenated radiolytic derivatives of water. Oxidation reactions preponderate; but reduction reactions are caused by hydroxyl radicals either directly, or indirectly by reaction with molecular hydrogen to give water and hydrogen atoms. It was suggested that hydrogen is produced chiefly by the process, $H_2O + e = H_2 + O^-$, which leads to the formation of two hydroxyl radicals and one molecule of hydrogen per ion pair. Dr. C. B. Amphlett (Harwell) described experiments in which the oxidation of ferrous ions by X- and γ-radiation was studied in dilute sulphuric acid solutions of different concentrations and in the presence and absence of complexing agents. The variation in the initial oxidation-yield with *p*H suggests that the primary act is more complex than is usually assumed. Values of the 'equivalent redox potential' of irradiated water with respect to the ferrous–ferric system were obtained. Dr. W. M. Garrison and Prof. G. K. Rollefson (Berkeley) described elegant tracer experiments on aqueous solutions containing ferrous ion and carbon-14 dioxide irradiated with high-energy helium atoms, and found that the principal products were ferric ion and hydrogen in the molar ratio two to one; formic acid and much smaller amounts of formaldehyde and oxalate were produced. A mechanism giving a rate law which agrees with the experimental data was proposed.

Papers mainly concerned with the decomposition of hydrogen peroxide followed. Dr. J. Weiss (Newcastle upon Tyne) discussed the photochemical decomposition in relation to that by ionizing radiations, and obtained rate expressions for the reactions

occurring within, and between, the tracks. Dr. E. J. Hart and M. S. Matheson (Chicago) described experiments with continuous and intermittent γ-radiation on aqueous hydrogen peroxide solutions in paraffin-coated cells, in which they found that the decomposition yield depended on the square root of the hydrogen peroxide concentration and inversely on the square root of the dosage-rate. A novel feature of the mechanism proposed was that chain termination results from the termolecular reaction $2HO_2 \rightarrow H_2O_2 + O_2$, in which hydrogen peroxide is regarded as being a third body of exceptionally high efficiency. Dr. M. Ebert and J. W. Boag (London) reported experiments on the decomposition of water and hydrogen peroxide by electrons and X-rays, showing that with neutral water there is no dependence on the intensity of the radiation, but that in acid solution the equilibrium concentration of hydrogen peroxide produced by large doses depends on the intensity. The mechanism proposed received some confirmation by further work on hydrogen peroxide produced in neutral aerated water by 30 and 220 kV. X-rays and 1·2 MeV. electrons by these workers in collaboration with Dr. M. Lefort (Paris and Leeds), H. C. Sutton (Leeds) and M. Ebert and Tikvah Alper (Hammersmith) using different analytical techniques. Dr. T. J. Hardwick (Chalk River) showed that, in the indirect action of X- and γ-radiation on aqueous ferrous and ceric sulphates, the yield varies with the initial energy of the ionizing electrons, and that this effect may be explained on the basis of existing theories of the primary action of ionizing radiation on water. The probability of the recombination of hydrogen atoms and of hydroxyl radicals was calculated as a function of the instantaneous electron energy.

Dr. E. Collinson and Prof. Dainton (Leeds) showed that the kinetics of the polymerization of aqueous acrylonitrile solutions induced by X- and γ-rays are strongly different from photochemical or catalysed reactions, and are consistent with an inhomogeneous distribution of the radicals formed from water, while at higher dose-rates an increasing degree of homogeneity is indicated. The three types of radiation used produced the same results. In heavy water (D_2O) solution irradiation leads to the formation of deuterium atoms which participate in the polymerization. In the discussion it was suggested that the unusual kinetics might in part be due to the insolubility of polymer in monomer.

The remaining papers dealt with more complex systems: Dr. G. Stein (Jerusalem) described the reactions of certain dyes in aqueous and non-aqueous systems, drew comparisons with biological systems and then discussed the role of the hydroxyl radical, free electrons and molecular oxygen in the radiation chemistry of organic substrates. Tikvah Alper (Hammersmith) reported experiments on the indirect inactivation of bacteriophage by ionizing radiations, and gave survival curves under various conditions. Dr. W. M. Dale (Manchester) discussed the possible protective effect of a second solute which may act as a competitive acceptor of free radicals, and the use of this effect, which is specific, as a measure of the protective power of various solutes. Dr. C. B. Allsopp and J. Wilson (London) showed that the quantity of indole decomposed in aqueous solution by X-rays increases with increasing concentration of indole and with decreasing dosage-rate. The radiation and the photochemical decompositions follow similar courses. Dr. W. Minder and H. Heydrich (Berne) discussed the results of their experiments on the irradiation of halogenated hydrocarbons in organic solvents, which show that the formation of halogen acids depends on the dose, the concentration of the solution, the number of halogen atoms in the compound and the type of binding.

The meeting was very successful on both the scientific and social sides, and may fulfil the hope expressed by Sir Charles Goodeve at the guest-night dinner that it would stimulate the development of radiation chemistry as much as a previous discussion many years ago had that of the closely related subject of photochemistry. The papers, together with discussion on them submitted in writing to the secretary, will appear later as a separate publication of the Faraday Society.

J. W. Belton

SCIENTIFIC EDUCATION OF PHYSICISTS

THE pamphlet "The Scientific Education of Physicists"*, recently issued by the Institute of Physics, is a report prepared by the Education Committee of the Institute which should act as a useful guide, for students who wish to enter the profession of physics and for those who have the responsibility of advising or teaching such students, to the facilities available for the education and training of physicists.

The Institute recognizes only two qualifications as satisfying completely the academic requirements for election to corporate membership—an approved degree from a recognized university, and the Institute's own graduateship examination—although partial exemption from the graduateship examination may be claimed by those who have previously obtained the Higher National Certificate in applied physics. In addition to the suitable degree courses at university institutions, the report refers to the several technical colleges which provide advanced courses in physics, usually for the external degree of the University of London, but it warns the intending student that very often such technical colleges, with the exception of the London Polytechnics and a few of the main provincial colleges, have poor facilities for teaching physics and very rarely do their resources extend to an honours course in physics. Moreover, since he will find it extremely difficult to obtain adequate financial assistance at a technical college, for the student who wishes to continue and do post-graduate research, usually leading to the M.Sc. or Ph.D. degrees, it is almost essential that he should study at a university institution. However, many of the major technical, as well as university, institutions do run excellent part-time courses, series of lectures and summer schools on advanced topics in physics which practising physicists will find of great value.

The report emphasizes the importance to the science student of an ability to express himself clearly, concisely and easily in English, both in speech and in writing. Recent discussion in the press has not settled whether the admitted prevalence of a low standard in English among physics students is due to lack of attention at the school or at higher levels; but in the report it is attributed mainly to individual negligence. The report concludes with appendixes giving factual data relating to the individual physics departments of all the universities and university

* The Scientific Education of Physicists. Pp. 32. (London: Institute of Physics, 1952.) 2s.

colleges of Great Britain and Northern Ireland and of those technical colleges recognized by the Institute. As most universities are now revising their regulations, the information given in the report should be treated with some caution. It is always wise for the intending student to make early and direct application to the university institution or college concerned and to obtain the most up-to-date information. It would have been a good thing if some such indication had been added to the report.

POSTERIOR PITUITARY GLAND

SYMPOSIUM AT CAMBRIDGE

A VERY informative session took place in the Physiological Laboratory, Cambridge, on June 20, when the Society for Endocrinology held a symposium on the posterior pituitary gland. This meeting was unique in the sense that so many of the speakers had made substantial contributions to our knowledge concerning this gland, and that so much more overall information is available for the posterior pituitary than any other endocrine gland.

The control of the secretion of the antidiuretic hormone was discussed from two different points of view. Dr. P. A. Jewell and Prof. E. B. Verney gave an account of their recent work dealing with the localization of the osmoreceptors. Intracarotid injection of hypertonic sodium chloride solution inhibits water diuresis by causing release of the antidiuretic hormone. However, the exact site of the receptor elements (osmoreceptors) stimulated by this hypertonic solution is not known for certain. Anatomical investigation of the vascular bed of the internal carotid artery showed that this vessel supplies the pituitary gland, the anterior hypothalamus including the greater part of the supraoptic and paraventricular nuclei, as well as other parts of the prosencephalon. Proof was given that the osmoreceptors do not lie in the pars nervosa of the pituitary. The findings in an animal in which an internal carotid artery had been tied intradurally suggest that the receptors lie in the prosencephalon. Dr. Mary Pickford emphasized that the supraoptic nerve cells, that give rise to the majority of nerve fibres which supply the posterior pituitary, can be activated by different types of stimuli, some arriving by nervous pathways, some being directly chemical, and some being physical or physico-chemical. She described the release of antidiuretic hormone from the posterior pituitary gland following injection of acetylcholine, nicotine, morphine and ferritin. Acetylcholine is rendered temporarily ineffective in this respect after application of di*iso*propylfluorophosphonate to the supraoptic nuclei. Intracarotid injection of adrenaline given prior to an antidiuretic dose of acetylcholine regularly annuls the action of the latter. It is of much interest that morphine is still effective in inhibiting a high rate of urine flow if applied directly to the supraoptic nerve cells, whether or not the cholinesterase of the cells of the supraoptic nuclei have been inactivated by di*iso*propylfluorophosphonate.

Prof. H. B. van Dyke, of the Department of Pharmacology, College of Physicians and Surgeons, Columbia University, then dealt with the subject of posterior pituitary extracts. Ten years ago van Dyke, Chow, Greep and Rothen[1] extracted a protein from the pars nervosa of the pituitary with the biological activities of both (antidiuretic – pressor and oxytocic) principles in about the same ratio as they are found in the gland. Its molecular weight was found to be about thirty thousand, and its biological activity was found to be low (1 unit = 61 μgm.). Although considerable evidence has been obtained that oxytocic and antidiuretic activities are present in constant ratios and that the protein is homogeneous, the possibility of adsorption of highly active principles on to an inert protein molecule has not been excluded. The highly purified principles recently isolated by du Vigneaud and his co-workers were discussed by Prof. van Dyke[2–5]. These principles have been isolated in a highly active form, 1 unit of the oxytocic principle being contained in 1·25 μgm. and 1 unit of the antidiuretic – vasopressor principle in 1·6 μgm. The amino-acid content of these two principles has been investigated, and it has been found that tyrosine, cystine, aspartic acid, glutamic acid, glycine and proline are common to both, whereas arginine and phenylalanine characterize the oxytocic principle and leucine and *iso*leucine characterize the antidiuretic – vasopressor principle. Using these principles, various workers have established that neither the contraction of the isolated rat uterus nor the ejection of milk by the lactating mammary gland is a specific test for the oxytocic principle, whereas the depressor response of the fowl's blood pressure appears to meet this requirement provided that contamination by antidiuretic – vasopressor principle is not excessive. The extremely sensitive antidiuretic test in the dog was found to be specific for the antidiuretic – vasopressor principle. It is not yet possible to decide from the published investigations whether the neurohypophysis secretes a large molecule containing both oxytocic and antidiuretic – vasopressor principles, or smaller molecules of highly active principles. The separate secretion of the latter has more teleological attraction.

In the next contribution, Prof. H. Heller dealt with the fate of the posterior pituitary (antidiuretic) hormone when secreted into the blood. Previous work had shown that antidiuretic extracts are rapidly inactivated by defibrinated blood, serum and liver homogenate. When injected intravenously the antidiuretic activity of posterior pituitary extracts disappears rapidly from the circulating blood, and antidiuretic activity appears in the urine. Recent unpublished experiments of Ginsburg and Heller have shown that the liver and kidney both play a part in the 'clearance' of the antidiuretic principle: it would seem that, in addition to excreting it, the kidney also removes it by another, as yet unknown, process. The question of the renal excretion of the antidiuretic principle, both of endogenous and of exogenous origin, was discussed in further detail.

B. A. Cross described the evidence underlying the present concept of a milk ejection reflex[6–8]. It can now be taken as established that the act of suckling stimulates a nervous reflex excitation of the posterior pituitary gland, and the secretion from this gland causes contraction of some element of the mammary gland and thus a positive ejection of milk from the mother to the young. Recent work using du Vigneaud's highly active oxytocic and antidiuretic extracts indicates that the posterior pituitary principle underlying milk ejection is the oxytocic principle and not a mixture of the two, as had been previously suggested. Mr. Cross also discussed unpublished work in which it was found that previous administration of adrenaline, or electrical stimulation of the posterior region of the hypothalamus with

resultant sympathetic excitation, will inhibit the milk ejection reflex. Since the same procedures inhibit the milk ejection effect of posterior pituitary extract, it is likely that the effect of adrenaline is, at least in part, on the mammary gland itself. Dr. A. G. Lewis dealt with recent work on the secretion of the antidiuretic hormone in normal man. It is satisfying to know that many of the laboratory findings are being confirmed on the human. After eighteen hours of dehydration a normal subject had posterior pituitary hormone in the circulation with an antidiuretic activity equal to (approximately) 20 mU. of 'Pitressin'. It seems unlikely that the 5 mU./ml. of antidiuretic substance which have been detected by rat assay of human serum have any physiological action. Direct assay in the human subject has shown that human serum contains less than 0·1 mU./ml. after twelve hours of dehydration. Emotional stimuli, the intravenous infusion of acetylcholine, or of hypertonic saline, nicotine, morphine, anæsthesia and surgical operations and syncope may all produce large releases of the antidiuretic hormone in man.

The final speaker at the symposium, Dr. J. E. Cates, described the results of an investigation, in collaboration with Dr. O. Garrod, on fifteen patients with diabetes insipidus. 'Pitressin' tests separate the rare 'Pitressin'-resistant cases. Water deprivation gives results which vary in degree. Hickey and Hare's test with hypertonic saline may be nullified by an osmotic diuresis. Nicotine intravenously causes little or no antidiuresis when given in doses large enough to cause antidiuresis in normal subjects; larger doses usually cause some antidiuresis. The effect of nicotine in clinical diabetes insipidus supports the belief that nicotine stimulates the secretion of the antidiuretic hormone. The response to large doses suggests that the lesion to the supraopticohypophysial system is often not complete.

[1] van Dyke, H. B., Chow, B. F., Greep, R. O., and Rothen, A., *J. Pharmacol.*, **74**, 190 (1942).
[2] Livermore, A. H., and du Vigneaud, V., *J. Biol. Chem.*, **180**, 365 (1949).
[3] Pierce, J. G., and du Vigneaud, V., *J. Biol. Chem.* **182**, 359 (1950).
[4] Pierce, J. G., and du Vigneaud, V., *J. Biol. Chem.*, **186**, 77 (1950).
[5] Turner, R. A., Pierce, J. G., and du Vigneaud, V., *J. Biol. Chem.*, **191**, 21 (1951).
[6] Cross, B. A., and Harris, G. W., *Nature*, **166**, 994 (1950).
[7] Cross, B. A., and Harris, G. W., *J. Endocrinol.*, **8**, 148 (1952).
[8] Andersson, B., *Acta Physiol. Scand.*, **23**, 1 (1951).

LONG ASHTON RESEARCH STATION

REPORT FOR 1950

THE plant pathologist and the engineer tend to run their separate ways, sparing a modicum of liaison for each other, but rarely understanding the subject of plant pathological engineering as a whole. The annual report of the Agricultural and Horticultural Research Station, Long Ashton, Bristol*, is perhaps most noteworthy for a determined attempt to consider the problems of the plant pathologist and engineer together. H. G. H. Kearns and N. G. Morgan publish an abridged specification of an experimental 'air-flow' small-volume drift sprayer and duster. This is designed to investigate the most efficient method of conveying very small drops of concentrated control materials to their disease targets, thus dispensing with large volumes of liquid, obtaining better penetration of the spray or dust cloud into foliage, and withal bringing great economy of the fungicide or insecticide. This material is fed into the blast from a fan delivering a large volume of air at low pressure.

New conceptions must not, however, be allowed to overshadow the solid worth of papers on more usual subjects. Nutritional studies include investigations on zinc and copper deficiencies of crop plants (E. J. Hewitt and E. W. Jones), work on iron metabolism in plants by the same authors contributing separate papers, and research on molybdenum and nitrate status in relation to yield and ascorbic acid levels in cauliflower (S. C. Agarwala; W. Plant). The wealth of detail and of interaction in all these results is summarized in the introduction to the report by the director of the Station, Prof. T. Wallace (pp. 13–15). L. C. Luckwill and D. Woodcock have a preliminary report on the nature of the hormone which occurs in the endosperm of developing apple seed. It is, *inter alia*, acidic, heat stable, soluble in ether and water, is destroyed by hydrolysis with strong acid or alkali, and cannot be identical with indolylacetic acid. A further report on pruning systems and tree shape on yield and quality of apples is given by R. M. Jarrett. Any pruning reduces yield; but normal winter pruning improves quality. Allington and Cox's Orange Pippins cropped better as modified leader trees; but Worcester Pearmain gave more produce as an open-centre tree. Continuing their studies of the nutrition of the black currant, C. Bould and E. Catlow find that yield varied as leaf nitrogen status, which decreased according to the following order of manurial treatments: nitrogen plus phosphorus > sewage sludge > nitrochalk plus compost > straw sludge compost > farmyard manure > no manure. D. J. D. Nicholas and W. A. Forster consider the effects of copper, zinc, lead, cobalt, nickel and manganese in excess on tomatoes and other crop plants. This is an important study, for excesses of 'micro' elements figure in advisory work in addition to deficiencies of these elements.

Long-term work on spray materials superior to lime–sulphur for the control of apple scab has been continued by R. J. W. Byrde and R. W. Marsh. They found that glyoxalidine 341-*C* at 1 quart per 100 gallons equalled the standard lime–sulphur treatments on Cox's Pippin, and was less phytotoxic. The new spray was also less damaging to foliage of Lane's Prince Albert and Stirling Castle than lime sulphur. A phthalimide preparation (*SR*-406) promises good fungicidal performance and freedom from phytotoxicity.

F. W. Beech and S. W. Challinor discuss changes in the pectin and nitrogen contents of apple juices as a first part of a larger study of maceration and defecation in cider making. Fermentation of ciders can also be controlled by centrifuging; L. F. Burroughs and S. W. Challinor consider the mechanism of this action in some detail. B. T. P. Barker continues his investigation of cider yeast floras with a paper on that of Kingston Black ciders. Margaret E. Kieser and A. Pollard discuss the effect of fruit storage on the processing of apple juice, and, with C. F. Timberlake, the effect of manurial treatment on the composition of black currants. Other shorter papers are included in the report, which is edited by R. W. Marsh, and numerous half-tone and line illustrations help to maintain its usual high standard of production.

* University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (the National Fruit and Cider Institute), Long Ashton, Bristol, 1950. Pp. 217+13 plates. (Bristol: The University, 1951.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Heat Flow through the Floor of the Eastern North Pacific Ocean

THE flow of heat through the earth's crust has been measured many times at various continental locations, and is usually found to lie[1] within 50 per cent of $1{\cdot}2 \times 10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$. Because of the absence of granitic rocks, with their relatively high radioactivity, in the crust under the oceans, it has been suggested that the heat flow through the deep-sea floor might be considerably smaller; but the only data available from oceanic areas have been two measurements of the thermal gradient in deep-sea sediments reported by Pettersson from the Swedish *Albatross* expedition[2].

In 1949, Dr. E. C. Bullard spent the summer at La Jolla in the preliminary development of an instrument for measuring temperature gradients in the sea floor. During the following year, development of instruments of the general type proposed by Dr. Bullard was continued under the direction of J. D. Isaacs and J. M. Snodgrass, and in the summer of 1950 a series of measurements was taken as part of the work of the joint Scripps Institution of Oceanography – United States Navy Electronics Laboratory Mid-Pacific Expedition, on the Scripps research vessel *Horizon*.

A hollow steel spear, 1·64 in. in outside diameter and 10 ft. long, was plunged vertically downward into the bottom sediments and allowed to remain in place for thirty to forty minutes. At its upper end the spear was attached to a heavy steel cylinder containing a self-recording, self-balancing null potentiometer which recorded continuously against time, to about 0·001° C., the difference in temperature between two thermal elements in the spear. The upper element was situated 24·0 in. beneath the sea bottom, and the recording case, and the lower element 81·5 in. beneath the upper element and 18·5 in. from the spear end. The thermal elements were connected thermally to the outside of the spear but were insulated electrically and protected from the outside hydrostatic pressure. We have satisfied ourselves from theory and experiment that the record of temperature difference against time obtained in this way can be extrapolated to give a value which corresponds within a few per cent to the undisturbed temperature gradient in the bottom sediment.

At each locality where the temperature gradient was measured, cores of the sediment were collected for laboratory determination of the thermal conductivity; care was taken to preserve these samples in as undisturbed a condition as possible and without change in water content. The conductivity determinations were made by D. W. Butler at the National Physical Laboratory. Because of the high water content of the sediments, the conductivities are much lower than those in rocks and approach the conductivity of sea water ($1{\cdot}3 \times 10^{-3}$ cal. sec.$^{-1}$ cm.$^{-1}$ ° C.$^{-1}$).

The measured temperature gradients and thermal conductivities at six stations and the computed values of the heat flow are given in the accompanying table.

Latitude (North)	Longitude (West)	Depth of water (m.)	Temperature gradient (° C. m.$^{-1}$)	Conductivity (cal. sec.$^{-1}$ cm.$^{-1}$ ° C.$^{-1}$)	Heat flow (cal. cm.$^{-2}$ sec.$^{-1}$)
20° 48′	159° 42′	4,500	0·07	$1{\cdot}8 \times 10^{-3}$	$1{\cdot}3 \times 10^{-6}$
18° 18′	173° 23′	3,900	0·04	$2{\cdot}2 \times 10^{-3}$	$0{\cdot}9 \times 10^{-6}$
19° 28′	174° 35′	4,900	0·06	$2{\cdot}0 \times 10^{-3}$	$1{\cdot}2 \times 10^{-6}$
16° 45′	176° 24′	5,040	0·07	$1{\cdot}8 \times 10^{-3}$	$1{\cdot}3 \times 10^{-6}$
19° 02′	177° 19′	4,750	0·07	$1{\cdot}6 \times 10^{-3}$	$1{\cdot}1 \times 10^{-6}$
32° 35′	132° 30′	4,000	0·07	$1{\cdot}8 \times 10^{-3}$	$1{\cdot}3 \times 10^{-6}$

Although the number of measurements is small, it is noteworthy that at five of the six localities, covering a total distance of nearly three thousand miles, the computed heat flow lies within 10 per cent of the average value for the continents. From field evidence, it is likely that in the observation at long. 173° 23′ W. the spear did not penetrate completely into the sediment, and that consequently the recorded value for the temperature gradient at this locality is too low.

The heat flowing from the deep Pacific floor could represent at least in part a 'fossil' temperature gradient in the sediments, remaining from a time when the bottom-water temperature was higher than the present 1·60°. Short-period temperature fluctuations cannot be significant because observations indicate that deep-water temperatures in the North Pacific have remained constant within a few hundredths of a degree for the past twenty-five years. On the other hand, a markedly different climate five hundred to two thousand years ago might possibly have resulted in somewhat higher bottom-water temperatures in the tropics than those now prevailing. A bottom-water temperature of 4·5° one thousand years ago would account for half the observed gradient.

It might be supposed that the heat flowing from the deep-sea floor has been generated by processes within the sediments, such as biological activity, submarine weathering, radioactivity and compaction. Calculations show, however, that the total effect of these four processes cannot result in production of more than $0{\cdot}05 \times 10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$—about 4 per cent of the observed heat flow.

If the heat flowing from the sea floor does not originate within the sediments, it must come from the underlying rocks of the earth's crust and mantle. Seismic refraction measurements made by R. W. Raitt on the Mid-Pacific expedition show that the Mohorovičić discontinuity between the crust and the mantle lies within five to nine kilometres of the sea floor. If the material above this discontinuity is similar in content of radioactive substances to oceanic basalt, then only 15 per cent of the observed heat flow can originate in the crust. If we also assume that the heat is carried from the earth's interior by conduction, and that following Jeffreys[3] the thermal conductivity is 5×10^{-3} cal. cm.$^{-1}$ sec.$^{-1}$ ° C.$^{-1}$, only some 20 per cent of the total heat flow can be accounted for by cooling of the earth. The remaining 65 per cent could be supplied by disintegration of radioactive substances in the mantle. But the required content of radioactive materials is so high that, if the radioactivity is uniform with depth or decreases exponentially, the mantle below about 130 km. would melt within a time short compared to 3×10^9 years. It is therefore necessary to assume either that radioactive materials are concentrated in the outer part of the mantle under the ocean, or that the heat is being transported outward by convection in the mantle. If a steady state of convection exists, more

than sufficient heat would be generated in a mantle having a uniform potassium content equivalent to that of stony meteorites[4]. In either case, however, we have the paradox that if the mantle under the continents is similar to that under the ocean, then the heat flow from the continents should be much higher than the observed value because of the presence of highly radioactive rocks in the outer parts of the continental crust.

A heat flow of $1{\cdot}2 \times 10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$ through the ocean floor should noticeably heat the bottom-water masses as they flow northward from the Antarctic. With a velocity of northward flow of the order of 0·1 cm. per sec., as suggested by Sverdrup, Johnson and Fleming[5], the temperature of a layer of bottom water 1 km. thick would increase by about one-tenth of a degree centigrade on its journey from the region of sinking in the Antarctic to the tropics. This amount of heating would be largely masked by mixing with high-temperature water from above. But with the much smaller velocity of northward flow suggested by some recent workers, there should be a much larger increase in the bottom-water temperature between the Antarctic and low latitudes. Such an increase is not observed. The possibility exists, therefore, that our measurements are not representative of the heat flow through the sea floor. Obviously many more measurements must be taken before reliable generalizations can be made.

Roger Revelle
Arthur E. Maxwell

Scripps Institution of Oceanography,
University of California,
La Jolla, California.
June 1.

[1] Bullard, E. C., *Nature*, **156**, 35 (1945).
[2] Petterson, H., *Nature*, **164**, 468 (1949).
[3] Jeffreys, H., "The Earth", 85, 2nd edit. (1924).
[4] Birch, F., *J. Geophys. Research*, **56**, 107 (1951).
[5] Sverdrup, Johnson and Fleming, "The Oceans", 754 (1946).

The preceding communication by Revelle and Maxwell gives a result which is completely unexpected, and demonstrates again how little we know of submarine geology. Their observations do, I believe, demonstrate that the heat flow is roughly the same under the oceans and continents. It seems most unlikely that this is a temporary condition dependent on recent large changes in the temperature of the bottom water, for this is largely determined by the existence of ice in the Arctic and Antarctic. The ice cannot have melted since the last ice age, because the water from it would drown the greater part of the continents. It seems almost certain that the heat found by Revelle and Maxwell must be generated by radioactivity in the rocks beneath the oceans, and therefore that the total amount of radioactivity beneath unit area of continent and ocean is the same when summed down to a depth of a few hundred kilometres (heat generated deeper down has not had time to escape). This would be very surprising if the continents were formed from a primitive sialic layer not present under the oceans, and are underlain by material which is the same under continents and oceans. It would, however, be natural if the continents are continuously expanding by a process of differentiation in which radioactive material is concentrated vertically[1]. The rocks beneath the oceans would then have the same total amount of radioactivity as those beneath the continents, but spread through a greater range of depth; this would give the same heat flow as beneath the continents, but higher temperatures at depth.

As is pointed out by Revelle and Maxwell, some upward concentration is necessary to avoid melting under the oceans. Calculation suggests that if the radioactivity were spread through a depth of 150 km., no impossibly high temperatures would be produced. A possible interpretation of the results therefore appears to be that when the earth solidified most of the radioactivity was concentrated in the upper 150 km. of the mantle; under the oceans this distribution still exists, but under the continents a further concentration has occurred into the top 10 or 20 km. On this view it would be expected that the oceanic ultra-basic rocks would contain more radioactive material than the continental ones. There are few reliable measurements; but those that do exist do not show such a difference. This matter should be further investigated.

Other explanations can be suggested. It might, for example, be supposed that at some not too remote time a convection current rose under the Pacific and brought hot material near the surface, or that the horizontal limb of a convection current had transported material from beneath the continents to the central Pacific. Such suggestions are pure speculation, and there is no other evidence in their favour.

The difficulties may be connected with that of reconciling the oceanic seismic and gravity results. The gravity results suggest that the material beneath the Mohorovičić discontinuity may not be quite the same beneath the continents and oceans in spite of the close agreement in seismic velocities. Some discussion of these matters is given in a book[2] to be published shortly.

E. C. Bullard

National Physical Laboratory,
Teddington.
June 18.

[1] Wilson, J. T., *Trans. Roy. Soc. Canad.*, **43**, 157 (1949).
[2] Bullard, E. C., in "The Solar System", **2**, chap. 3, edit. by G. P. Kuiper (Chicago Univ. Press).

Use of a Gamma-Ray Pinhole Camera for *in vivo* Studies

The pinhole camera method of taking gamma-radioautographs, though it has been described in the literature[1], has had very little use because of the long exposure times which are necessary even when the most sensitive radiographic films are used. An intensifying screen for use with the pinhole camera has now been developed which has made it possible to reduce the exposure time considerably. The screen consists of a large, flat crystal of thallium-activated sodium iodide. The gamma-rays produce scintillations in the crystal which in turn affect the photographic plate. This method has made it possible to take an *in vivo* gamma-ray pinhole radioautograph of a tumour containing 20 millicuries of iodine-131.

A drawing of the pinhole camera and intensifying screen is shown in Fig. 1. A gamma-ray from the object being photographed goes through the pinhole and travels in a straight line until it enters the sodium iodide crystal, where it may produce a Compton or photoelectric recoil. The recoil electron travels about a millimetre or less in the crystal. The light

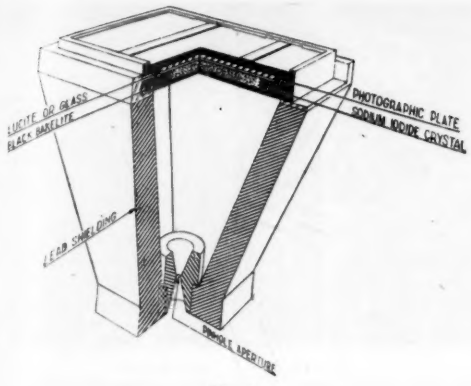


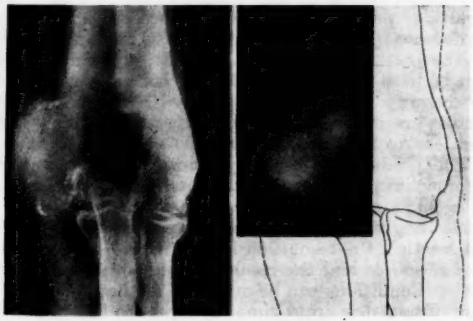
Fig. 1

produced along the path of the recoil is emitted isotropically. The spreading of the light over the photographic plate and the consequent loss of definition are limited both by inverse square law attenuation and by total reflexion from the glass-to-air boundary between the crystal and photographic plate. The angle of total reflexion is about 35°. The light reflected from the glass surface passes back through the crystal and is absorbed by the black 'Bakelite' container.

There is a considerable loss in definition due to spreading of the light from the thick intensifying screen, even though it is limited as described above. In ordinary radiographic work this would not be permissible; but due to the relatively poor definition obtained from the pinhole camera, the additional loss in definition is relatively unimportant. In order to get good optical contact between the crystal and the glass window, and also to protect the crystal from the effects of moist air, it is contained in a bath of Monsanto Chemical Co. 'Aroclor No. 1248'.

The camera was tested by taking autoradiographs of bottles of iodine-131 solution. It was found that a concentration of about 1 mC./cm.^{2} and an exposure time of 1 hr. were sufficient to give a faint but usable image of the source. This is about twenty times less exposure time than is necessary if Kodak No-Screen film is used with the lead-foil intensifying screens customarily used for gamma-ray radiographs.

The exposure times given above are for the following conditions. The pinhole size was 1/8 in.; the pinhole-to-intensifying screen distance 7½ in.; the intensifying screen was a crystal of thallium-activated sodium iodide crystal 2 in. × 4 in. × 5/16 in. thick, obtained from the Harshaw Chemical Co., 1945 East 97th Street, Cleveland 6, Ohio; the photographic plate was a Kodak type 103a—0 spectroscopic plate slightly overdeveloped in *D*-19 developer.



(*a*) X-ray radiograph. (*b*) Pinhole autoradiograph

Fig. 2. Metastasis of thyroid tumour at elbow

As mentioned before, the camera has been used for taking an *in vivo* gamma-ray autoradiograph of a tumour containing iodine-131. The tumour was a metastasis of a thyroid carcinoma. It was close to the skin, had a volume of 90 ml. and an area of about 20 sq. cm. The picture was taken 24 hr. after a therapeutic dose of 100 mC. iodine-131 was administered to the patient. It was determined independently that 20 mC. lodged in the tumour. A one-hour exposure was taken and the resulting picture is shown in Fig. 2*b*. The general outline of the area which took up the iodine-131 is shown, together with the fact that it is concentrated in two main areas. An X-ray radiograph of the tumour taken from the same point of view is shown in Fig. 2*a*.

I wish to acknowledge consultation with Dr. C. A. Tobias and also the assistance of Drs. Frank Pierce and Enrique Strajman in supplying information about the patient. This work was performed under the auspices of the Atomic Energy Commission, Contract W-7405-eng-48.

H. O. Anger

Donner Laboratory,
Radiation Laboratory and
Division of Medical Physics,
University of California,
Berkeley, California.
May 1.

[1] Copeland, D. Eugene, and Benjamin, Emanuel W., *Nucleonics*, **5**, No. 2, 44 (1949).

Microradiography with Alpha-Rays

Alpha-particles are very strongly absorbed even by thin layers of materials. Their path through matter is almost exactly a straight line, and their effect on a photographic emulsion is very strong. These properties seem to be well suited for microradiographic mass determinations. Since such methods promise to be of value in several research fields, such as biology, medicine, mineralogy and metallurgy, experiments have been undertaken to determine the potentialities and optimal conditions for alpha-microradiography. The main advantage of using alpha-particles as compared with soft X-rays[1] would be the much simpler apparatus needed and the relative independence of the absorption on the composition of the object.

From purely geometrical considerations it is evident that to obtain high picture-resolution the alpha-particles must be collimated to normal incidence upon the object. Further, the object must be placed as near as possible to the photographic emulsion, and the grain-size of the emulsion should be small enough to allow the necessary enlargement. The collimation is most simply accomplished as in other types of radiography; the source of alpha-rays is placed at a distance from the object, which is large compared with the size of the source and the object.

When arranging for optimal mass resolution, that is, good contrast between areas differing in mass per unit area, the special mechanism of alpha-absorption must be borne in mind. The alpha-particles, being fast helium ions, are gradually slowed down

(1) (2) (3)

Alpha-microradiographs of a section 10 microns thick of cancer of the skin forming keratin. (× 50.) The photographic density increases with decreasing mass per unit area

Source : 3·5 millicuries polonium-210, diameter 2 mm. ; distance, source to object, 130 mm. ; film, Lippmann emulsion 84·890 1 *M* ; number of incident particles per square micron, 40

Energy of the alpha-particles entering the object corresponds to ranges of : (1) 0·6 cm. ; (2) 1·1 cm. ; (3) 1·6 cm. (in air at a pressure of 760 mm. mercury and a temperature of 15° C.)

through interaction with the electrons in the absorber. The number of elementary processes in this slowing down is sufficiently large to give a relatively low statistical variation (straggling) in the total range. This variation is only a few per cent of the total range, and is well represented by a Gaussian distribution.

An alpha-particle which has passed through a thin part of the object differs from one that has passed through a thicker part in that its residual range is greater, and it will thus penetrate deeper into the photographic emulsion. If the residual range of the alpha-particles after passing through the object is large compared with the straggling, the number of alpha-particles hitting unit area of the film is constant. The contrast is then solely dependent on the variation of photographic density with residual range. For normal incidence, it seems probable that this variation should be small except at small residual ranges. To obtain good contrast, the energy of the alpha-particles should thus be chosen so that they are almost completely stopped by the object. In this case, however, the straggling will be an important factor in the contrast produced, since a lower number of the alpha-particles will reach the film under thick areas than under thin areas. One would thus anticipate that the photographic density will vary with the thickness in a rather limited region of mass per unit area. On the other hand, the contrast should be very good.

The microradiographs chosen to illustrate this discussion were taken on the same object, the number of incident particles per unit area and the geometrical arrangement being held constant. The energy of the particles entering the object was varied by changing the air pressure in the space between source and object.

It is seen that in the thicker areas of the object the picture is white without contrast, and in the thinner areas the picture is uniformly black. In the intermediate regions the mass distribution can be measured by photometric comparison with the blackness under reference absorbers. The pictures show that by increasing the energy of the impinging particles the measurable region is moved towards thicker regions. By taking a sufficient number of radiographs with alpha-particles of varying energy, all the areas can be accurately measured. It is evident that all areas can be measured in one radiograph by using thin enough sections or an alpha-particle source emitting particles of a wide variety of energies. This means, however, sacrificing some of the mass-resolving power.

By using particles of homogeneous energy under oblique incidence, a large interval of linear dependence of photographic density on mass per unit area should be obtained. This, on the other hand, means sacrificing some of the resolution of the picture.

A more comprehensive publication concerning alpha-microradiography will be published elsewhere.

Gunnar Aniansson
Naftali Steiger

Division of Physical Chemistry,
Royal Institute of Technology,
Stockholm 70.
Feb. 13.

[1] Engström, A., and Lindström, B., *Biochimica et Biophysica Acta*, **4**, 351 (1950).

Diffraction Microscopy with X-Rays

In a recent communication, A. V. Baez[1] predicts the practical resolution obtainable by diffraction microscopy using X-rays. His prediction is based on the required conditions for making the hologram. Similar derivations were described by us at the International Conference on Electron Microscopy in Paris, September 1950, though unfortunately we are still awaiting publication of the proceedings of this conference. Our derivation relates to the application of the method to electron irradiation where lenses can be used for producing intense coherent sources or to magnify the diffraction image (hologram). Our results are immediately applicable to the X-ray case and lead to the same conclusions as reached by Baez.

The predictions made by Baez that a resolution approaching 10^{-8} cm. could be obtained by the use of a point source or a grainless film are somewhat misleading since neither case is a physical possibility. In practice, the resolution is determined by both the size of source and the resolution of the photographic plate. Conditions can be arranged so that the resolution obtained is approximately equal to half the size of the source or resolution of the plate, whichever is the smaller. This, in fact, represents no worthwhile

improvement in resolution over that which can be obtained by direct methods, for a point projection microscope will give a resolution equal to the size of source, and shadow microscopy (object in contact with photographic plate) will give a resolution equal to that of the plate. The theory shows an apparent gain in resolution of 2 ×. There is some doubt, however, whether this is a real gain or whether it is lost as a result of the use of coherent illumination; for example, to resolve two coherent Airy patterns, twice the separation required for incoherent radiation is necessary.

M. E. Haine
T. Mulvey

Research Laboratory,
Associated Electrical Industries, Ltd.,
Aldermaston, Berkshire.
June 19.

[1] Baez, A. V., *Nature*, **169**, 963 (1952).

Surface Oxide Films in Intermetallic Contacts

Bowden and Hughes[1] have shown that removal of surface oxide films can endow metals with very high coefficients of friction. To examine to what extent these films, when present, prevent metallic contact, electrical resistance measurements have been made on the loaded junction between crossed cylinders ($\frac{1}{4}$ in. in diameter) of various metals, their axes being perpendicular. The apparatus was designed to minimize vibration. The metallic constriction resistances have been calculated from theoretical considerations which have been discussed by Holm[2] and plotted against the applied normal loads. Experimental curves for gold and silver between 10 gm. and 10 kgm. agreed closely with the calculations. High resistances obtained with other metals indicated the presence of poorly conducting films in the contacts. Some of the curves could be explained quantitatively by assuming the films to be uniform and stable.

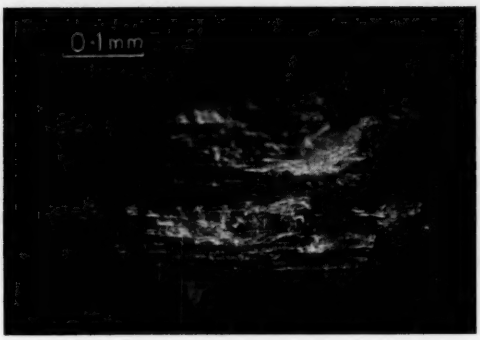


Fig. 2. Damage to stainless-steel cylinder; displacement increases from left to right

With electropolished stainless steel and copper, the resistance remained high under loads up to 10 kgm. Fig. 1 shows the effect of applying an increasing lateral force (in the axial direction) to one of the normally loaded cylinders. The broken curves show the relative lateral displacement of the cylinders, measured by an optical lever device. Initially, the resistance was unaffected, and the small displacement could be attributed to strain in the cylinders and mountings. At a certain critical force, there was a fall in resistance accompanied by a sudden displacement. This force was much smaller than the usual friction force; but the resistance to motion increased rapidly with further displacement. The curves shown are for stainless steel; but those for copper are similar, except that the movement at the critical force is less sudden.

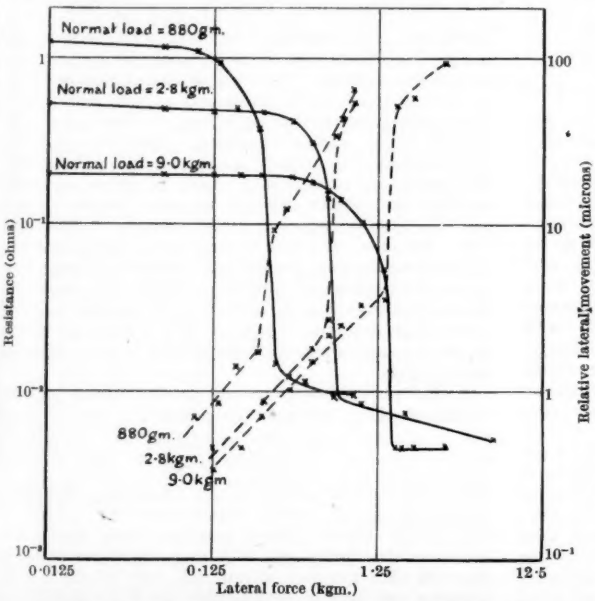


Fig. 1. Resistance *vs.* tangential force curves for stainless steel crossed cylinder contacts under various normal loads: ———, resistance; – – – –, lateral movement

Microscopic examination showed that when the critical force was just exceeded, the damage to the contact surfaces was slight; greater lateral displacement rapidly increased the damage. With stainless steel, the damage formed a number of distinct tracks which later developed into torn patches (Fig. 2); but with copper the whole contact area became torn.

It has already been shown[3], using the radioactive method, that sliding enormously increases the transfer between metals in contact. The experiments described above show that the films on some metal surfaces are not penetrated under normal loading; a small lateral force is necessary to form metallic contacts. Subsequent lateral movement then raises the friction by increasing the area of intermetallic contact.

With cylinders lubricated by a thick layer of stearic acid, perceptible sliding began under a small force which did not increase very rapidly with displacement. The coefficient of friction could not be measured accurately, but was of the order of 0·01. Visible damage to the contact surface was confined to a few thin scratches. Fluctuations in resistance which accompanied any change in lateral displacement suggested that, when metallic contact was made, it was usually broken again by the lubricant. This supports the suggestion[4] that an

important function of a lubricant is to prevent the growth of any small welds which may form.

M. Cocks

Research Laboratory,
Associated Electrical Industries, Limited,
Aldermaston Court,
Aldermaston, Berks. Feb. 5.

[1] Bowden, F. P., and Hughes, T. P., *Proc. Roy. Soc.*, A, **172**, 263 (1939).
[2] Holm, R., "Electric Contacts", 79 (Uppsala, Almquist and Wiksells, 1946).
[3] Kerridge, M., Proceedings—Isotopes Techniques Conference, Oxford, July 1951, **2**, 26 (H.M.S.O., 1952). Rabinowicz, E., and Tabor, D., *Proc. Roy. Soc.*, A, **208**, 458 (1951).
[4] McFarlane, J. S., and Tabor, D., *Proc. Roy. Soc.*, A, **202**, 251 (1950). Hirst, W., Kerridge, M., and Lancaster, J. K., *Proc. Roy. Soc.*, A, **212**, 516 (1952).

Contrasting Methods of Transmission of Animal Viruses by Mosquitoes

Recent investigations[1] of the mechanism of the transmission of myxomatosis of rabbits by mosquitoes have brought to our attention certain clear-cut differences between the transmission by mosquitoes of those diseases in which a 'biological cycle' occurs in the insect vector, and those in which carriage is purely mechanical. Among the animal viruses, it is only in fowlpox[2,3] and myxomatosis[1,4] that mosquito transmission has been conclusively shown to be mechanical in nature. In all the other mosquito-transmitted virus diseases that have been adequately studied (dengue, yellow fever, the viral encephalitides, and Rift Valley fever), there is a 'biological cycle' in the mosquito. Certain implications of these contrasting modes of transmission are summarized in the accompanying table.

	'Mechanical'	'Biological'
Source of virus	skin lesions	bloodstream
Specificity of mosquito vector	nil	high
Interrupted feeding	positive	negative
Extrinsic incubation period (latent period)	none	present
Arthropod transmission the only natural mechanism	no	yes
Multiplication of virus in mosquito	no	yes

Mechanical transfer by mosquitoes may be expected to occur in any disease in which a high skin concentration of a relatively resistant virus occurs. It is not inconceivable that the 'airborne smallpox' reported around fever hospitals[5] was sometimes mechanically transmitted by mosquitoes, and cowpox may be spread thus among cows, as well as by the milker's hands. Similarly, swinepox may well be transferred from place to place by some more mobile mechanical vector than the hog louse[6]. Mechanical transmission is not incompatible with prolonged infectivity of the mosquito. Brody[3] obtained positive results with fowlpox at intervals up to forty-one days, and we found[1] that myxomatosis could be transmitted as long as twenty-five days after the infective feed.

If there is a viræmia but no deposition of virus in the skin, mechanical transmission by mosquitoes occurs only under exceptional conditions[7]. The data of Philip[8] and St. John *et al.*[9] appear to prove that the feeding mechanism of the mosquito is such that regurgitation does not occur. The opportunity for virus in the blood to contaminate the mouthparts appears to be slight, for in many diseases the virus is associated with the cellular elements of the blood, rather than circulating freely in the plasma[10,11].

Biting insects which are voracious 'pool feeders' may, on the other hand, be more likely to transfer virus present in the circulation, and this may be the explanation of the mechanical transmission of equine infectious anæmia by tabanid flies and *Stomoxys calcitrans*, but not by mosquitoes[12].

Appreciation of the features of mechanical and biological transmission of animal viruses shown in the table may help in elucidating the epidemiology of some of those diseases in which the role of insect vectors is not yet clear.

Frank Fenner

Department of Microbiology,
John Curtin School of Medical Research,
Australian National University,
Canberra.

M. F. Day

Division of Entomology,
Commonwealth Scientific and
Industrial Research Organization,
Canberra. Feb. 1.

[1] Fenner, F., Day, M. F., and Woodroofe, G. M., *Aust. J. Exp. Biol.*, **30**, 139 (1952).
[2] Kligler, I. J., and Ashner, M., *Brit. J. Exp. Path.*, **10**, 347 (1929).
[3] Brody, A. L., Cornell Univ. Agric. Exp. Stat. Mem. 195 (1936).
[4] Aragão, H. B., Mem. Inst. Oswaldo Cruz, **38**, 93 (1943).
[5] Millard, C. K., *Brit. Med. J.*, i, 628 (1944).
[6] Shope, R. E., *Arch. ges. Virusforsch.*, **1**, 457 (1940).
[7] Simmons, J. S., St. John, J. H., and Reynolds, F. H. K., *Philipp. J. Sci.*, **44**, 1 (1931).
[8] Philip, C. B., *Ann. Trop. Med. and Parasit.*, **24**, 493 (1930).
[9] St. John, J. H., Simmons, J. S., and Reynolds, F. H. K., *Ann. J. Trop. Med.*, **10**, 237 (1930).
[10] Smith, W., *Brit. J. Exp. Path.*, **10**, 93 (1929).
[11] Epstein, B., Fonseca, N. M., and DeRobertis, E., *J. Exp. Med.*, **94**, 171 (1951).
[12] Scott. J. W., *J. Amer. Med. Vet. Assoc.*, **9**, 448 (1920).

Non-random Distribution of Multiple Mitotic Crossing-over among Nuclei of Heterozygous Diploid *Aspergillus*

Somatic, or mitotic, crossing-over[1] occurs in nuclei of the mycelium of the homothallic ascomycete *Aspergillus nidulans*[2,3], made diploid and heterozygous for known markers by means of a new technique[3]. The asexual *Aspergillus niger* has now been found to behave in a similar manner; that is, diploids heterozygous for known markers give mitotic recombinants homozygous for one or more of these markers but usually still heterozygous for the others, and therefore undergoing further mitotic recombination. Detailed analysis of mitotic recombinants in *A. nidulans* further shows that mitotic crossing-over is not distributed at random between the nuclei of the mycelium but tends to be concentrated in a small proportion of them. The kind of evidence on which this conclusion is based is exemplified in the following paragraphs.

A diploid was used, having green conidia and no growth-factor requirement, of genotype

$$\frac{W\ \ ad_2\ \ y}{w\ \ AD_2\ \ Y}\ \frac{LYS}{lys}\ .$$

(W/w, coloured versus white conidia; AD_2/ad_2, independence of, versus requirement for, adenine; Y/y, green versus yellow conidia—these three loci linked in this order and with map distances of more than 50 cMo between w and ad_2, and about 7 cMo between ad_2 and y, w epistatic to Y/y. LYS/lys: independence of, versus requirement for, lysine, non-linked to the others.) In the chromosome carrying

the three linked genes the centromere is located between *w* and ad_2.

On the theory of mitotic crossing-over[1], one expects that recombinants homozygous at one locus should be usually homozygous also at other closely linked loci, especially if distal, but not usually at loci on the other arm of the same chromosome or on different chromosomes. From a diploid of the genotype given above, one would therefore expect that the homozygous *y* recombinants should be mainly homozygous for ad_2, which is proximal but only 7 cMo away, and the homozygous *w* mainly prototrophs, that is, still heterozygous for ad_2 and for *lys*. In fact, recombination giving homozygosis for both *w* and ad_2 requires two disparate exchanges, one in each arm, and homozygosis for both *y* (usually with ad_2) and *lys*, or for both *w* and *lys*, requires two exchanges, one in each of two chromosomes.

The results of testing strains from individual green conidia, or from individual mosaic spots of yellow or white colour, are as follows :

	Requiring :				Total tested
	adenine	lysine	both	neither	
Green	0	0	0	234	234
White	4	1	1	46	52
Yellow	13	0	2	1	16

The expectation that because of linkage most of the homozygous *y* should also be homozygous for ad_2 is fulfilled (15 out of 16). That homozygosis for ad_2 or for *lys* alone occurs rarely is shown by the fact that none of the 234 green shows it. That homozygosis for *w* or for *y* alone occurs rarely can be seen by inspection of growing colonies of the diploid, where rarely are more than twenty recombinant mosaic patches or single heads found in a whole Petri dish. A very crude estimate of homozygosis for ad_2 gives its occurrence as about once every 10 mitotic divisions. Yet among the 52 homozygotes for *w*, 5 are also homozygous for ad_2, and among the 68 homozygotes for *w* or/and *y*, 4 are also homozygous for *lys*. Thus homozygosis at two or more loci on different chromosome arms is far too frequent to be accounted for by chance coincidence of more than one exchange per nucleus.

Results with *Aspergillus niger* point in the same direction. In this species, however, while genetic analysis and experimental 'breeding' *sui generis* can now be carried out with the present technique, we cannot cross-check the results of this analysis with those of standard genetic analysis because of the absence of a sexual cycle.

Incidentally, our work shows that mitotic crossing-over occurs regularly if diploid nuclei are formed in species with an exclusively or mainly haploid life-cycle. We see now that Sansome[4] was probably correct when she suggested mitotic crossing-over as the cause of certain results in her work on *Penicillium*. This raises the question of whether or not crossing-over might be a general feature of chromosome synthesis. As diploid life-cycles evolved, it would have become confined mainly to meiosis by the emergence of special mechanisms preventing it in somatic cells.

G. Pontecorvo

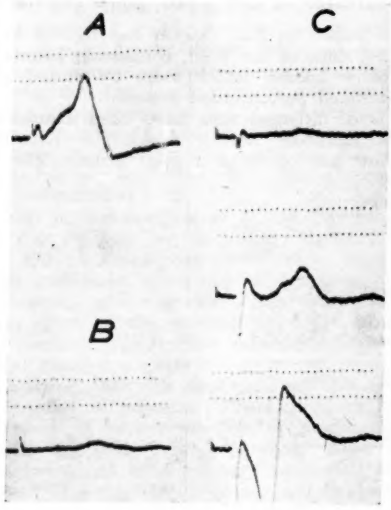
Department of Genetics,
University of Glasgow. Feb. 8.

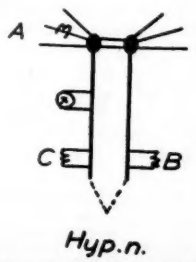
[1] Stern, C., *Genetics*, **21**, 624 (1936).
[2] Roper, J. A., *Experientia*, **8**, 14 (1952).
[3] Pontecorvo, G., and Roper, J. A., *J. gen. Microbiol.* (in the press).
[4] Sansome, E., *Trans. Brit. Mycol. Soc.*, **32**, 305 (1949).

Excitation of Ganglion Cells in the Inferior Mesenteric Ganglion by Collaterals

When the hypogastric nerve is stimulated with a current which is subthreshold for the postganglionic *C* fibres but sufficiently strong to stimulate the delta and *B* fibres, a number of cells in the inferior mesenteric ganglion are excited, and an impulse coming from the ganglion can be recorded in the hypogastric nerve. An impulse is also recorded on stimulation of the contralateral hypogastric nerve[1] (see diagram). If in a curarized preparation a conditioning tetanus is given preganglionically, a test shock to the postganglionic hypogastric nerve afterwards excites a larger number of ganglion cells. Now post-tetanic potentiation, also in the curarized ganglion, is exclusively localized to the stimulated fibres. Therefore these ganglion cells must have been excited through collaterals. This reflex persisted, when the afferent fibres, after bilateral excision of the spinal ganglions, Th 11—L VI, had been denervated. It was absent after sections and degeneration of the ventral roots of the same segments. Consequently, these collaterals are given off from efferent fibres which traverse the ganglion, and have their trophic centre in the spinal cord.

This is a confirmation of the tentative conclusion drawn by Langley and Anderson[1] concerning the pathway for the Sokownin crossed bladder reflex[2].





Stimulating electrodes on : (*A*) 2nd preganglionic nerve ; (*B*) contralateral hypogastric nerve ; (*C*) ipsilateral hypogastric nerve ; increasing strength of stimulation. 500 c./s.

If the hypogastric nerve is stimulated with a current strong enough to excite *C* fibres, it was regularly found that a synaptically relayed impulse can be recorded in the colonic nerve and occasionally also in another branch of the hypogastric nerve. In some experiments on the curarized ganglion, these reflexes were potentiated after preganglionic tetanization with a current supra-threshold for *C* fibres. Therefore also *C* fibres which traverse the ganglion can give off collaterals capable of exciting the ganglion cells.

After bilateral denervation of the preganglionic nerves, a reflex in the colonic nerve can still be recorded on stimulation of the hypogastric nerve at *C* fibre strength. This finding is consistent with the anatomical and physiological data presented by Kuntz and Saccomanno[3].

C. Job
A. Lundberg

Nobel Institute for Neurophysiology,
Karolinska Institutet,
Stockholm.
Feb. 7.

[1] Lloyd, D. P. C., *J. Physiol.*, **91**, 296 (1937).
[2] Langley, J. N., and Anderson, H. K., *J. Physiol.*, **16**, 410 (1894).
[3] Kuntz, A., and Saccomanno, G., *J. Neurophysiol.*, **7**, 163 (1944).

Senility Changes in the Spinal Ganglion Neurones of the Toad, *Bufo regularis*

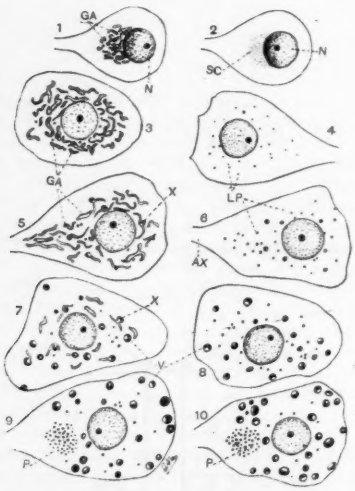
In a paper on fat, Ciaccio has figured various neurones, some of the toad, containing large spherical hollow bodies, which stain by Sudan III in formalin-fixed postchromed material.

Toads of different ages have been examined by various methods, among which the Kolatchew–Nassonow has provided a good series. The Golgi apparatus of the late tadpoles and the young toads is a canalicular reticulum which is polarized in the tadpoles (Fig. 1). In young toads few granules are visibly attached to the osmiophile reticulum (Fig. 3). As the full-grown toad ages, it is possible to follow the break-up of the canals to form a variable number of large spherical and sub-spherical bodies shown in the initial stage in Fig. 5. One such vesicle is being formed at *X*, by the widening of the canal into a vesicle, and the thickening of one side. In Fig. 7 the process of metamorphosis has become greatly advanced in the old toad, the Golgi reticulum having nearly disappeared. In the senile condition (Fig. 9) the Golgi apparatus has completely degenerated into a number of very large osmiophile vesicles (*v*), which are more concentrated at the cell periphery. These osmiophile vesicles stain clearly in Sudan black *B* in Regaud postchromed material, whereas the Golgi reticulum does not so stain. It is clear, therefore, that in old toads the Golgi material of the spinal ganglion neurones is transformed into lipid. Besides the above-mentioned vesicles, pigment granules are secreted by the Golgi apparatus; these granules are situated in the cell body and finally migrate to the axon hillock region. The mitochondria in the spinal ganglion neurones are granular. A further account of the material is being published elsewhere.

Tohamy A. Moussa

Zoology Department,
Faculty of Science,
Farouk University,
Alexandria.
Dec. 31.

References
Ciaccio, C., *Arch. Zellf.*, **5** (1910).
Gatenby, J., Brontë, and Ellis, J. L., *La Cellule*, **54** (1951).
Gatenby, J., Brontë, Moussa, T. A., and Dosekun, F., *La Cellule*, **53** (1949).
Gatenby, Moussa, Elbanhawy and Gornald, *La Cellule* (in the press).
Moussa, T. A., *Amer. J. Anat.*, **90** (1952).



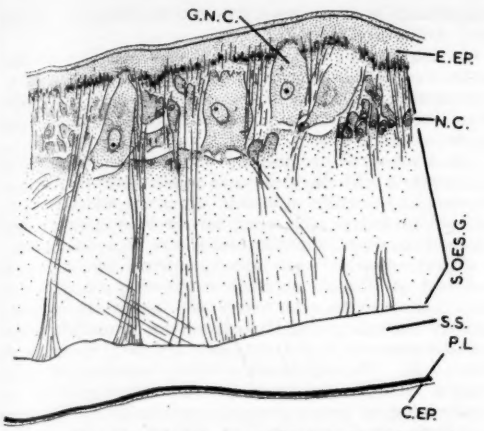
Semi-diagrammatic figures: Left-hand figures from Kolatchew–Nassonow preparations, right-hand figures from Regaud-postchromed Sudan black preparations. Figs. 1–2, tadpole. Figs. 3–4, young toad. Figs. 5–8, full-grown toad. Figs. 7–8, old toad. Figs. 9–10, senile toad. *AX*, axon; *GA*, Golgi apparatus; *LP* (Figs. 4 and 6), ordinary lipid granules (Golgi secretion), xyiol-solubie; *N*, nucleus; *P* (Figs. 7–10), pigment granules; *SC*, sudanophile cloud, the area *SC* being non-granular, but slightly sudanophile; *V*, osmiophile and sudanophile vesicles

Giant Nerve Cells in *Lingula*

Elongated invertebrate animals which effect quick muscular contractions, either as a means of rapid withdrawal and escape like some Annelida[1] and Enteropneusta[2], or for the purpose of making sudden darts through the water like the macrurous Crustacea[3] and the squids and cuttlefishes[4], have been shown to possess giant nerve cells and fibres.

Fifty years ago, Morse[5] observed that the two closely allied genera of ecardine Brachiopoda, *Lingula* and *Glottidia*, with long stalks by which they are attached to the bottoms of their tubes in sand or mud, withdraw into their tubes with a quick jerk on an interruption of the light which falls upon them. "The available descriptions of the nervous system in the Brachiopoda give us a picture of the arrangement in a few species but they do not supply in any point the modern demands. . . . About the form and nature of the nerve fibres we know only that the fibre mass is a net-work of fine fibrillæ and that the nerve cells like most cells of the Brachiopoda are very small and therefore difficult to investigate."[6]

However, working with fresh material fixed in Bouin's fluid, sectioned in paraffin and stained with hæmatoxylin and eosin, I have found a small number of giant nerve cells in the subœsophageal ganglion of *Lingula* (see diagram). I hope, by the use of more specific stains for nerve tissue, to be able to trace



Vertical section through the subœsophageal ganglion of *Lingula*. *C.EP.*, cœlomic epithelium; *E.EP.*, epidermal epithelium; *G.N.C.*, giant nerve cell; *N.C.*, nerve cell; *P.L.*, pigment layer; *S.OES.G.*, subœsophageal ganglion; *S.S.*, supporting substance. (× *c.* 250)

the processes of these cells to the muscles of the stalk and so to provide an explanation of the jerk noted by Morse.

P. KIRTISINGHE

Department of Zoology,
University of Ceylon. Feb. 19.

[1] Nicol, J. A. C., *Quart. J. Mic. Sci.*, **89** (1), 1 (1948).
[2] Bullock, T. H., *Quart. J. Mic. Sci.*, **86** (1), 55 (1945).
[3] Holmes, W., *Phil. Trans. Roy. Soc.*, B, **231**, 293 (1942).
[4] Young, J. Z., *Endeavour*, **3**, (11), 108 (1944).
[5] Morse, S. E., *Mem. Boston Soc. Nat. Hist.*, **5**, (8), 313 (1902).
[6] Helmcke, J. G., Brachiopoda in "Kukenthal and Krumbach's Handbuch der Zoologie", **3**, (2), 139 (1939).

Lactic Oxidases of *Mycobacterium tuberculosis avium*

WE have previously discovered that the cell-free preparation of *Mycobacterium tuberculosis avium* (Takeo strain) catalyses the oxidation of lactate. Recently, we have confirmed that this preparation contains two distinct lactic oxidases, and made clear the respective characteristic properties. One of these enzymes is a new type of lactate oxidative enzyme.

Enzyme activity was determined by measuring the oxygen consumption manometrically in Warburg apparatus. Lactate, the substrate, was determined manometrically with ceric sulphate. The product, a volatile acid, was steam-distilled and titrated. Pyruvate, the other product, was determined by the bisulphite-binding method of Clift and Cook and by the ceric sulphate method.

Mycobacterium tuberculosis avium, strain Takeo, was grown on the glycerol broth media. From the compact mass of harvested bacteria, the crude cell-free enzyme preparation was obtained by alternating freezing and thawing. This preparation was able to oxidize lactate with no addition. The addition of methylene blue, however, increased by 30–50 per cent the consumption of oxygen. When the extract was heated for 10 min. at 50° C., the effect of methylene blue was not changed appreciably. Dialysis against water at 0° C. for 12 hr. had no effect on the oxidation of lactate in the absence of methylene blue; but in the presence of methylene blue the effect of this dye was abolished (Table 1).

Table 1. EFFECT OF HEATING AND DIALYSIS ON LACTIC OXIDATION BY THE CRUDE ENZYME PREPARATION

Enzyme preparation	Oxygen uptake (c.mm.) per 60 min.	
	Without methylene blue	With methylene blue
Crude extract	101	210
Heated 10 min. at 50° C.	0	125
Dialysed 12 hr. at 0° C.	109	94

Warburg's vessels contain 2·0 ml. of enzyme preparation, 0·3 ml. of 0·2 *M* phosphate buffer (*p*H 6·2), and 0·2 ml. of 3 *M* DL-lactate.

These phenomena indicate that the preparation includes two distinct lactic oxidases: one is heat-labile, stable in dialysis, and reacts directly with molecular oxygen, whereas the other is relatively heat-stable, labile in dialysis and active only in the presence of methylene blue. For convenience, we named the former 'lactic oxidase I' and the latter 'lactic oxidase II'.

The crude preparation (Q_{O_2} (per mgm. dry weight) = 15) was brought to *p*H 3·8 with acetic acid and the precipitate was dried in a desiccator *in vacuo* at room temperature. The dried precipitate was suspended in phosphate buffer. The extracted residue was removed by centrifugation, and ammonium sulphate was added to the supernatant solution (Q_{O_2} = 150), bringing the solution to saturation. Repeating the precipitation by acetic acid and ammonium sulphate alternately, the purified lactic oxidase I (Q_{O_2} = 450) was obtained. In the course of purification, lactic oxidase II was destroyed completely.

Lactic oxidase I. The purified lactic oxidase I oxidizes aerobically DL-lactate with no addition. Neither methylene blue, thionine, nor the cytochrome *c* and cytochrome oxidase system has any effect. The Michaelis–Menten constant is 5×10^{-2} mole per litre, using DL-lactate as the substrate. The optimum *p*H is about 6·2. Neither cyanide, azide nor 8-hydroxyquinoline has any inhibiting effect; but silver nitrate and copper sulphate both inhibit the reaction almost completely at a concentration of 3×10^{-4} mole per litre. This enzyme has no readily dissociable co-factor. Various coenzymes, for example, diphosphopyridine nucleotide, adenosine triphosphate, flavine mononucleotide and magnesium ions, were found to have no effect on the enzyme activity. However, flavine adenine dinucleotide often stimulated the catalysed reaction slightly.

Anticipating that the coenzyme of this enzyme might be flavine adenine dinucleotide, we heated preparations of various degrees of purification at 85° C. for 15 min., and the clear supernatant fluids were added to a mixture consisting of the apoprotein of pig kidney D-amino-acid oxidase and DL-alanine; the content of flavine adenine dinucleotide was measured by determining the oxidation-rate of DL-alanine. The oxidation-rate of alanine due to these preparations increased remarkably with the increasing degree of purification. It was presumed, therefore, that the prosthetic group of this enzyme is flavine adenine dinucleotide.

Oxygen consumed, and volatile acid and carbon dioxide produced, are all found to be one mole per mole lactate. The reaction catalysed by this enzyme can therefore be expressed by:

$$CH_3CHOH—COOH + O_2 \rightarrow CH_3COOH + CO_2 + H_2O.$$

This enzyme does not attack pyruvate, whether co-carboxylase is present or not, and also lactate oxida-

Table 2. Characteristic Properties of Lactic Oxidases

	Lactic oxidase I	Lactic oxidase II
Method of extraction	Alternate freezing and thawing	Autolysis from acetone powder
Heated at 50° C. for 10 min.	Labile	Stable
Dialysis	Stable	Labile
Precipitated with acetic acid	Stable	Labile
With molecular oxygen	Reacts directly	Reacts in the presence of carrier
With methylene blue or cytochrome *c*	Not affected	Affected; the enzyme requires them as carriers
Prosthetic group or co-factor	Flavine adenine dinucleotide	Diphosphopyridine nucleotide
Reaction product	Acetate	Pyruvate

tion is not inhibited by pyruvate. It appears, therefore, that this enzyme catalyses the oxidation of lactate to acetate and carbon dioxide with no intervention from pyruvate.

The addition of alcohol, azide, cyanide, hydrogen peroxide and active catalase prepared from beef liver, respectively, has no effect on the rate of reaction, and the addition of alcohol with strong liver catalase has no effect on the total amount of oxygen consumed and carbon dioxide produced. Consequently, we consider that the possibility of the formation of hydrogen peroxide is ruled out.

Lactic oxidase II. A larger amount of lactic oxidase II is contained in the acetone-powder extract than in the extract which is obtained by alternate freezing and thawing. Although we have not succeeded in purifying this enzyme, the activation by methylene blue, the cytochrome *c* and cytochrome oxidase system, and diphosphopyridine nucleotide was demonstrated with the acetone-powder extract. In the presence of methylene blue, pyruvate was detected as the reaction product. The reaction catalysed will be perhaps as follows:

$$CH_3CHOH—COOH + \tfrac{1}{2}O_2 \rightarrow CH_3COCOOH + H_2O.$$

The characteristic properties of the two distinct lactic oxidases are summarized in Table 2. As shown in the table, lactic oxidase I is a new type of lactate-oxidizing enzyme differing from the lactic dehydrogenases of animal tissues, yeast, *E. coli*, *Gonococcus* and higher plants. Lactic oxidase II is similar to the animal enzyme.

Yuichi Yamamura
Masamiti Kusunose
Emi Kusunose

Toneyama Institute of Tuberculosis,
Municipal Medical School,
Osaka. Dec. 21.

Growth of Rat Ovary in Tissue Culture

There are few reports of rat tissue cultures producing growth comparable to that from other mammalian species or from chick explants. Martinovitch[1], working with rat pituitary and rat ovary in watch-glass cultures, was able to keep the tissues alive *in vitro* for a considerable length of time; but cell outgrowth was comparatively slight. Abercrombie and Harkness[2] cultured regenerating rat liver. Fibroblasts or bile duct epithelium rarely grew from normal liver cultures, but appeared sporadically in cultures of regenerating material, the outgrowth varying with the state of liver regeneration. Only lymphocytes and granulocytes occurred in cultures regularly and in similar numbers regardless of the state of regeneration. The only case of rat pituitary tissue producing vigorous growth *in vitro* is that reported by Haymaker and Anderson[3].

In the present experiments it has been found that extensive epithelial growth can be obtained in slide cultures of rat ovary if the explants are kept in a fluid medium for 24 hr. before being placed in the slide cultures.

As a result of preliminary cultures, it was decided that rats 27–31 days old and approximately 60 gm. in weight were the optimum age from which tissues should be taken. Histological sections showed that in such ovaries follicular tissue was at a maximum.

Whole ovaries were removed from the rats and washed in Simm's solution containing 10 per cent rat serum. From each ovary, the larger follicles were gently squeezed, and then from the remaining piece of ovary ten to fifteen explants 1–2 mm. in diameter were cut. The expressed follicles, together with the larger ovarian explants, were transferred to an embryological watch-glass containing 2 c.c. of culture medium, which consisted of 50 per cent rat serum, 50 per cent rat embryo extract and streptomycin in the final concentration 0·0002 per cent. The watch-glasses were covered with large coverslips, sealed and incubated for 24 hr. at 37° C.

This 'preincubated' tissue was now cultured by the slide method. Explants were moored to the coverslip in a thin rat plasma-extract clot; a drop of fluid culture medium similar to that used for 'preincubation' was added and a meniscus drop culture finally prepared. Control cultures were prepared using fresh rat ovary in fresh medium. All cultures were incubated at 37° C.

After 24–48 hr. incubation, on an average, 75 per cent of the cultures of 'preincubated' tissue showed growth; after a further 24 hr. epithelial sheets of cells were prominent. By renewing the fluid medium, cultures could be kept healthy for up to seven days, the final width of the growth varying from 2 to 4 mm. On an average, 40 per cent of the control cultures grew and produced epithelium, but to a lesser extent than the experimental cultures.

The reasons for growth promotion and the beneficial properties of 'preincubation' are as yet undetermined. Rat tissue may be sensitive to injury, and injured cells fall from the explants, thus leaving healthy cells for culture. In transferring the explants to a fresh medium before culturing by the slide method, products of cell damage may be washed off. Slight separation of cells may occur during 'preincubation'. The effects of different culture media, and of duration and temperature of 'preincubation', require further study. The effect of 'preincubation' on the subsequent growth *in vitro* of other rat tissues should also be investigated since the optimum conditions for one tissue are not necessarily those required by other tissues.

This work was carried out during a short visit to the National Institute for Medical Research, London, and I wish to thank Sir Charles Harington and Dr. A. S. Parkes for making my visit possible. I am also indebted to Dr. A. U. Smith for many helpful suggestions, and for her stimulating interest in the work.

Jean I. Scott

Department of Surgery,
University of Aberdeen. Feb. 6.

[1] Martinovitch, P., *Proc. Roy. Soc.*, B, 125, 232 (1938); 128, 138 (1939).
[2] Abercrombie, M., and Harkness, R. D., *Proc. Roy. Soc.*, B, 138, 544 (1951).
[3] Haymaker, W., and Anderson, E., *J. Path. and Bact.*, 42, 399 (1936).

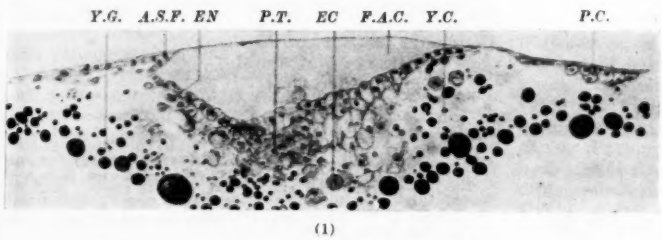
Development of the Embryonic Coverings in the Scorpion, *Buthus quinquestriatus* (H.E.)

During the period of proliferation of the embryonic disk of the scorpion (*Buthus quinquestriatus* (H.E.)), an amnio-serosal fold appears at the anterior periphery (Fig. 1). The posterior margin of the embryonic disk up to this stage does not show any trace of either the serosa or the amnion. This is contrary to the findings of Kowalevsky and Schulgin[1], who claimed that the amnio-serosal fold, in *Androctonus ornatus*, arises simultaneously around the whole margin of the embryonic disk.

As development proceeds, the anterior amnio-serosal fold extends gradually backwards above the future amniotic cavity (Fig. 2) and, at the same time, along the margin of the germinal disk.

Also during the extension of the fold, the outer periphery of the upper layer extends beyond the germinal disk, just below the vitelline membrane, while that of the lower one is kept attached to the blastoderm, which can be referred to, now, as the ectoderm.

At a later stage, the amnio-serosal fold continues its development around the whole margin of the germinal disk and its edges fuse with each other to form two embryonic coverings, namely, the serosa and the amnion.



(1)

(2)

Fig. 1. *Buthus quinquestriatus*. A longitudinal section in the embryonic disk of an early stage showing the anterior origin of the amnio-serosal fold. (× 225)

Fig. 2. *Buthus quinquestriatus*. A longitudinal section in the side of an embryonic disk of a more advanced stage showing the extension of the amnio-serosal fold. (× 225)

A.S.F., amnio-serosal fold; *A.S.F.*$_1$, marginal extension of the amnio-serosal fold; *EC*, ectoderm; *EN*, endoderm; *F.A.C.*, future amniotic cavity; *ME*, mesoderm; *P.C.*, primitive cumulus; *P.T.*, primary thickening; *V.M.*, vitelline membrane; *Y.C.*, yolk-cell; *Y.G.*, yolk granules; *S.M.*, serosa

The above description differs from those given by Laurie[2] in *Euscorpius italicus* and Brauer[3] in *Euscorpius carpathicus*. According to Laurie, the serosa develops, independently, before the amnion around the edges of the blastoderm as a single layer of cells, which becomes reflected dorsally and grows gradually until its edges meet and fuse in the middle, just below the vitelline membrane. The same author mentioned that the amnion appears from the edge of the blastoderm shortly afterwards as a single layer of cells below the serous membrane. He further stated that the serous membrane, at that moment, loses all connexion with the blastoderm and then grows gradually around the yolk. The description given by Brauer is very near to that of Laurie.

A. Abdel-Wahab

Department of Zoology,
Faculty of Science,
Fouad I University,
Orman, Giza,
Cairo.
June 15.

[1] Kowalevsky, A., and Schulgin, M., *Biol. Zbl.*, **6** (1886).
[2] Laurie, M., *Quart. J. Micro. Sci.*, **31** (1890).
[3] Brauer, A., *Z. Wiss. Zool.*, **59** (1895).

Seasonal Change in the Humidity Reaction of the Common Earwig, *Forficula auricularia*

In an investigation on physiological and ecological problems in *Forficula auricularia*, van Heerdt[1] found that well-fed, non-desiccated earwigs showed no humidity preference in the alternative chamber; but if previously desiccated, the earwigs became distinctly hygropositive. Whenever *Forficula* is found in dry places, its presence there is, according to van Heerdt, to be ascribed to thigmotaxis. Experiments begun in the winter of 1946–47 gave results closely resembling those of van Heerdt. In the summer of 1949, however, when the experiments were continued, the earwigs (both specimens taken directly from very dry natural conditions, and specimens kept in moist air even for weeks) showed a clear and strong preference for the drier side of the alternative chamber. Two-hour experiments were carried out in the day-time, but in darkness with the exception of short intervals for counting. With a choice between 100–34, 100–97, 100–99·5, 97–87, 77–34, 34–20 and 34–0 per cent relative humidity, the drier humidity was consistently preferred by the summer earwigs. Desiccation, however, caused even the summer earwigs to choose the moist air. These same specimens, well-fed and kept in a moist atmosphere all the time, so that the effect of desiccation was excluded, were investigated in the following winter. It appeared that the animals no longer showed the dry reaction, but tended now to prefer 100 to 34 per cent relative humidity. The experiments were repeated in the summer of 1950 and winter of 1950–51, with results similar to those obtained in the earlier years.

The accompanying table shows the difference in reaction in summer and winter, the intensity of reaction being expressed as the excess percentage, $\frac{100\,(W - D)}{N}$, on the moister side, where W represents the number on the moister side (100 per cent relative humidity), D the number on the drier side (34 per cent relative humidity), and N the total number of insects; + means reaction towards moist, and − means reaction towards dry. These experiments were carried out in the light.

	Time in minutes						No. of position records
	1–5	6–10	11–15	16–20	21–25	26–30	
Intensity of reaction during July–August	−49	−55	−53	−57	−67	−72	900
Intensity of reaction in January	+19	+37	+41	+64	+69	+66	1,800

These results are in full accordance with the ecology of the species. It is well known[2] that in the autumn earwigs burrow into the soil for hibernation and egg-laying, the fresh soil in the burrows keeping the air constantly humid. In view of this the disappearance of the strong dry reaction of the summer earwigs in the winter is quite understandable. These results, however, still need confirmation with earwigs taken directly for experiment from their burrows in the soil in the winter.

These investigations on the humidity sense in *Forficula* will be continued, and the results will be published fully elsewhere.

My thanks are due to Prof. J. E. Harris for help and facilities in the Zoological Department, University of Bristol.

Vilho Perttunen

Zoological Department,
University of Bristol.
(Present address:
Zoological Laboratory,
University of Helsinki.)

Feb. 15.

[1] van Heerdt, P. F., "Eenige physiologische en oecologische problemen bij Forficula auricularia", thesis, Utrecht (1946).
[2] Beier, M., "Dermaptera", Orthopteren I, in Schulze's "Biologie der Tiere Deutschlands" (Berlin, 1933).

Maximum Molecular Weight of Insulin

Current investigations on the molecular weights of enzymic digests of insulin prompted the redetermination of the sedimentation and diffusion constants of the untreated crystalline protein. This work has given results which differ considerably from the previously published figures for this substance[1].

In phosphate buffer, *p*H 7·4, the mean of seven determinations in the Spinco ultracentrifuge gave $s_{20,w} = 3{\cdot}12 \pm 0{\cdot}02$ (S.D.) Svedberg units. This value was independent of concentration in the range 0·4–0·8 per cent, of temperature in the range 17–26° C., and of ionic strength in the range 0·10–0·30. The experimental details of operation of the ultracentrifuge were as previously described[2,3]. Diffusion coefficients were determined with the Gouy diffusiometer[4], the use of which with proteins has recently been discussed[3]. At *p*H 7·4, and ionic strength 0·10, the results shown in the accompanying table were obtained.

The diffusion coefficients given are the means of two, or more generally four, determinations, and are expressed in units of 10^{-7} cm.^{2} sec.$^{-1}$. They were independent of temperature in the range 14–30° C.

Diffusion Coefficients of Insulin at *p*H 7·4

Concentration (per cent)	$D_{20,w}$	Concentration (per cent)	$D_{20,w}$
0·181	9·57	0·300	8·50
0·196	9·03	0·328	8·23
0·238	8·74	0·380	8·23
0·257	8·91	0·482	8·34
0·266	8·77	0·684	8·23

The values were calculated from the movement of the outermost interference minimum in the experimental record, which gives a D_A average; calculation of D_m for the most concentrated solution by the method of Ogston[5] gave 8·16 for this quantity. The diffusion behaviour, therefore, approximates to the ideal at this concentration.

This work provides qualitative confirmation for the dissociation phenomena reported from osmotic measurements by Gutfreund[6], for concentrations lower than about 0·3 per cent, but gives a different value for the molecular weight in the stability range. Thus, using the values $s = 3{\cdot}12$, $D = 8{\cdot}2$, application of the Svedberg equation gives $M = 34{,}800$ for $\bar{v} = 0{\cdot}735$ (see Pedersen[1]), or 36,700 on the older value[7], $\bar{v} = 0{\cdot}749$. Gutfreund[6] obtained $M = 48{,}000$ under these conditions.

The value of 35,000–36,000 refers to the maximum molecular weight of insulin as it exists in solution (investigations at *p*H 7·0 and 7·2 gave similar results) and so is in satisfactory agreement with the X-ray determination[8] of the molecular weight in the solid state, namely, 36,000.

At *p*H 8·0, lower values of the sedimentation constant and higher values of the diffusion coefficient have been obtained; details of these and other results will be included in a full account of this work, to be published shortly elsewhere.

J. M. Creeth

Courtauld Institute of Biochemistry,
Middlesex Hospital,
London, W.1.

May 23.

[1] Sjögren, B., and Svedberg, T., *J. Amer. Chem. Soc.*, **53**, 2657 (1931). Polson, A., *Koll. Z.*, **87**, 149 (1939). Miller, G. L., and Andersson, K. J. I., *J. Biol. Chem.*, **144**, 459 (1942). Gutfreund, H., and Ogston, A. G., *Biochem. J.*, **40**, 432 (1946). Pedersen, K. O. Cold Spring Harbor Symp. Quant. Biol., **14**, 140 (1950). Frederico, E., and Neurath, H., *J. Amer. Chem. Soc.*, **72**, 2684 (1950). Oncley, J. L., Ellenbogen, E., Gitlin, D., and Gurd, F. R. N., *J. Phys. Chem.*, **56**, 85 (1952).
[2] Charlwood, P. A., *Biochem. J.*, **51**, 113 (1952).
[3] Creeth, J. M., *Biochem. J.*, **51**, 10 (1952).
[4] Coulson, C. A., Cox, J. T., Ogston, A. G., and Philpot, J. St. L., *Proc. Roy. Soc.*, A, **192**, 382 (1948).
[5] Ogston, A. G., *Biochem. J.*, **45**, 189 (1949).
[6] Gutfreund, H., *Biochem. J.*, **42**, 156 and 544 (1948).
[7] Svedberg, T., and Pedersen, K. O., "The Ultracentrifuge" (Oxford: University Press).
[8] Crowfoot Hodgkin, D., Cold Spring Harbor Symp. Quant. Biol., **14**, 65 (1950).

A Synergistic Interaction between 3-Indolylacetonitrile and 3-Indolylacetic Acid

Experiments carried out with 3-indolylacetonitrile, recently isolated by Jones, Henbest, Smith and Bentley[1] from brussels sprouts, have indicated that the substance may function either as a plant growth regulator or can be converted within the plant to a substance with growth-regulating properties.

Some experiments carried out in this Department, with a pure sample of the 3-indolylacetonitrile, kindly supplied by Prof. E. R. H. Jones of Manchester, were designed to substantiate a further explanation for the activities shown by this compound.

Jones *et al.* have stated that in the *Avena* straight-growth test the nitrile is more active than the corresponding 3-indolylacetic acid and have shown that a 10-mgm./l. solution of the nitrile in the presence of *Avena* coleoptiles may produce, in twenty-four

hours, an acid with an activity equivalent to a concentration of less than 0·1 mgm./l. of 3-indolylacetic acid. If the nitrile was broken down to the acid by the plant, it is clear from the results quoted by these workers that up to 50 per cent of the elongation due to the nitrile at 10 mgm./l. could be ascribed to the conversion of the nitrile to 3-indolylacetic acid. Several possible explanations have been proposed by these workers to account for the greater activity shown by the nitrile in this test. First, the nitrile itself may be active, and the resultant elongation is the summation of the effects of the nitrile and the acid. Secondly, the plant cells may be more permeable to the nitrile than the acid and this, coupled with the breakdown of nitrile within the cells, might lead to a higher internal concentration of acid than that attained if the tissue was immersed in the acid alone at the same concentration. There would appear to be a further possible explanation. The nitrile could be inactive, but might act as a synergist to 3-indolylacetic acid present naturally within the plant tissue or formed by the breakdown of the nitrile. Thus, the data of Jones *et al.* could be interpreted as follows. Up to 50 per cent of the activity of a 10-mgm./l. solution of nitrile could be due to conversion to the acid, while the remaining activity could be attributed to a synergist effect of the nitrile upon the 3-indolylacetic acid.

In the standard Went pea curvature test[2] Jones *et al.* found that the nitrile was inactive at concentrations below 20 p.p.m., indicating that any breakdown to 3-indolylacetic acid which may have occurred at these concentrations was too small to be detected by the assay. The rigorous proof of synergism between two active compounds is often difficult, but such an interaction can be more readily demonstrated if one of the compounds concerned is inactive. For these reasons experiments were carried out with pea tissue in preference to *Avena* tissue to determine whether, in fact, the nitrile could act as a synergist to applied 3-indolylacetic acid.

DEGREE OF CURVATURE OF SPLIT PEA EPICOTYLS
(Went standard test)
(Curvatures shown as mean number of degrees, ± standard error)

3-Indolylacetic acid concentration—p.p.m.	3-Indolylacetonitrile concentration—p.p.m.		
Experiment 1	0	20	
0	0	0	
0·1	2 ± 1	57 ± 11	
1·0	108 ± 10	157 ± 9	
2·5	120 ± 5	159 ± 12	
Experiment 2	0	5	50
0	0	0	25 ± 6
0·1	2 ± 1	7 ± 4	81 ± 11
0·5	34 ± 5	38 ± 8	136 ± 12
1·0	65 ± 7	95 ± 10	127 ± 12

The results for two experiments are given in the table. In concentrations up to 20 p.p.m. the nitrile induced no positive curvatures. At each concentration of 3-indolylacetic acid, the addition of 20 p.p.m. of the nitrile resulted in an increase in curvature which is statistically significant. With 5 p.p.m. of the nitrile, the increase is small and non-significant, but is still positive. At 50 p.p.m. the nitrile itself exhibits some activity but the curvature produced is less than that given by 0·5 p.p.m. of 3-indolylacetic acid alone. When, however, 50 p.p.m. of the nitrile is combined with 0·5 p.p.m. of the acid, the curvature obtained is significantly greater than that produced by 1·0 p.p.m. of 3-indolylacetic acid. Thus the evidence for synergism between these compounds in pea tissue seems clear, and it is therefore suggested that the synergistic or hemiauxin activity of the nitrile in the presence of 3-indolylacetic acid is a further factor for consideration in assessing the growth-regulating activity shown by this new plant product.

DAPHNE J. OSBORNE

Agricultural Research Council,
Unit of Experimental Agronomy,
Department of Agriculture,
Oxford.
June 24.

[1] Jones, E. R. H., Henbest, H. B., Smith, G. F., and Bentley, J. A., *Nature*, **169**, 485 (1952).
[2] Went, F. W., *Proc. Kon. Akad. Wet. Amsterdam*, **37**, 547 (1934).

Hydrogen Transfer by Thiols

THE thermal decomposition of α,α′-azoethylbenzene in inert solvents at 125° C. leads, apart from a quantitative production of nitrogen, to methylbenzyl radicals which combine to meso and racemic 2,3-diphenylbutane. Disproportionation of the radicals does not occur since ethylbenzene could not be detected (1).

$$C_6H_5(CH_3)CH{-}N{=}N{-}HC(CH_3)C_6H_5 \rightarrow N_2 + 2\,C_6H_5(CH_3)\dot{C}H \quad (1)$$

However, in the presence of a twice molar proportion of a thiol such as *n*-octane-1-thiol or thiophenol, dehydrogenation to phenyl methyl ketazine takes place, the amount of nitrogen evolved in the course of the reaction dropping to about 58 per cent (2, 3). Part of the methylbenzyl radicals formed is hydrogenated to ethylbenzene, the balance giving 2,3-diphenylbutane or other products. Apparently, thiyl radicals are more reactive than methylbenzyl radicals, since they are capable of abstracting a hydrogen atom from the azo compound, eventually converting it into the ketazine.

$$C_6H_5(CH_3)\dot{C}H + RSH \rightarrow C_6H_5(CH_3)CH_2 + RS\cdot \quad (2)$$

$$2\,RS\cdot + C_6H_5(CH_3)CH{-}N{=}N{-}HC(CH_3)C_6H_5 \rightarrow 2\,RSH + C_6H_5(CH_3)C{=}N{-}N{=}C(CH_3)C_6H_5 \quad (3)$$

Active hydrogen donors like 9,10-dihydroanthracene, which scarcely react with methylbenzyl radicals, are readily dehydrogenated to compounds like 9,9′,10,10′-tetrahydrodianthranyl-9,9′, in the presence of thiols (4, 5).

$$RS\cdot + HD\ (\text{hydrogen donor}) \rightarrow RSH + D\cdot \quad (4)$$
$$2\,D\cdot \rightarrow D_2$$

Hydrogen donor and azo compound will compete for the thiyl radicals, the amount of nitrogen evolved being a measure of the reactivity of the former. In the system α,α′-azoethylbenzene (1 mole), *n*-octane-1-thiol (2 moles) and 9,10-dihydroanthracene (1 mole), the amount of nitrogen evolved is increased to 98 per cent again.

It was found that only one mole of thiol disappears for every four moles of ethylbenzene formed, thus showing that the thiol acts as a hydrogen transfer agent.

Other aliphatic azo compounds, for example, 2,2′-azo-*iso*butyronitrile, can also be used for the

dehydrogenation of active hydrogen donors when thiols are present.

In view of the ready formation of thiyl radicals from thiols even by relatively inert radicals—as is evident from the extremely high chain-transfer constants in vinyl polymerization[1]—the above high reactivity of *R*S radicals with respect to dehydrogenation would seem surprising. Thus, the heat of reaction of (6) should be equal to the sum of the heat effects of (2) and (4), although (6) would appear to be very much slower.

$$C_6H_5(CH_3)\dot{C}H + HD \rightarrow C_6H_5(CH_3)CH_2 + D\cdot \quad (6)$$

However, a close parallel between heats of reaction and activation energies can be expected only in the case of closely analogous reactions, that is, reactions involving the same reacting functional groups. Thus, it may well be that in the reactions (7) and (8) the relationship between activation energy and heat of reaction is quite different from that in hydrogen abstractions involving only hydrocarbons and hydrocarbon radicals.

$$R_1\cdot + R_2SH \rightarrow R_1H + R_2S\cdot \quad (7)$$

$$R_2S\cdot + R_3H \rightarrow R_2SH + R_3\cdot \quad (8)$$

Furthermore, it seems conceivable that the fast rate of (4) as compared with that of (6) is merely due to a higher concentration of the *R*S radicals as compared with that of the methylbenzyl radicals. On the other hand, such a difference should be caused by a faster rate of dimerization of the methylbenzyl radicals as compared to that of the *R*S radicals, which seems somewhat unlikely.

The above results suggest that the activation energies of reactions of type (7) and (8) are rather low. In consequence, these reactions might well be reversible even at room temperature. As a result, they may play an important part in biochemical oxidation and reduction processes.

A detailed account of this work will be published in the near future. Our thanks are due to the management of the Bataafsche Petroleum Maatschappij for permission to publish this communication.

A. F. Bickel
E. C. Kooijman

Koninklijke/Shell-Laboratorium,
Amsterdam.
Jan. 16.

[1] Burnett, *Quart. Rev.*, **4**, 313 (1950).

Thiol Catalysis of the Homolytic Decomposition of Aldehydes

The homolytic decarbonylation of aliphatic aldehydes regularly occurs at elevated temperatures in the vapour phase[1]. We have studied this reaction with a number of aliphatic aldehydes in the liquid phase at 90°–120° C., using the $Me_2\dot{C}—CO_2Me$ free radical (produced by the thermal decomposition of dimethyl-2 : 2′-azo-*iso*butyrate) as the initiating catalyst, and have found that only about 5 per cent of these radicals are effective as dehydrogenators (1).

$$Me_2\dot{C}—CO_2Me + R—CHO \rightarrow Me_2CH—CO_2Me + R—CO\cdot \quad (1)$$

Only a short reaction chain (2–3) can be concerned in the liberation of carbon monoxide, and this is probably terminated by (4).

$$R—CO\cdot \rightarrow R\cdot + CO \quad (2)$$

$$R\cdot + R—CHO \rightarrow R—H + R—CO\cdot \quad (3)$$

$$R—CO\cdot + Me_2\dot{C}—CO_2Me \rightarrow R—CO—CMe_2—CO_2Me \quad (4)$$

Even when the molar proportions of aldehyde to azo ester are as low as 5 : 1, the amount of carbon monoxide evolved was never more than that of the nitrogen formed from the azo-compound : the average extent of aldehyde decomposition was less than 8 per cent, and benzaldehyde gave no carbon monoxide. Carbon tetrachloride, with which *R*—CO· radicals react easily, was a very effective inhibitor of the chain process (2–3).

Our results accord with those of Winstein and Seubold[2], who effectively decarbonylated β-phenyl-*iso*valeraldehyde at 130° using *t*-butyl peroxide as the radical-producing catalyst, but reported that benzoyl peroxide at 80° initiated very little action. By using the more active $CH_3\cdot$ radicals from acetyl peroxide at 65°, Kharasch, Urry and Kuderna[3] have, however, reported up to 20 per cent decarbonylation of aldehydes even in the presence of olefins. From the small extent of the decarbonylation at moderate temperatures, it can be inferred from all these observations that some at least of the reactions (1–3) must require a significant amount of activation energy.

When, a few months ago, Drs. Kooijman and Bickel, of the Koninklijke/Shell Laboratorium, Amsterdam, kindly informed us that thiyl radicals, Alk—S·, were more effective dehydrogenators of 9 : 10-dihydroanthracene than were α-methyl-benzyl radicals[4], we investigated the effect of adding a little benzyl mercaptan to mixtures of aliphatic aldehydes and azo-compounds and obtained quite striking results. The addition of as little as 0·5 mol. per cent of the thiol to our mixtures increased the extent of aldehyde decomposition, as measured by carbon monoxide evolution, to 80–90 per cent for α-branched aldehydes, such as 2-ethyl-hexanal, and to a lesser but still marked extent with *n*-aldehydes. Hence the chain sequence :

$$Me_2\dot{C}—CO_2Me + Tol—S—H \rightarrow Me_2CH—CO_2Me + Tol—S\cdot \quad (5)$$

$$Tol—S\cdot + R—CHO \rightarrow Tol—S—H + R—CO\cdot \quad (6)$$

then (2) followed by

$$R\cdot + Tol—S—H \rightarrow R—H + Tol—S\cdot \quad (7)$$

must be much more effective than the reaction chain (1–4) above, and, in particular, (6) and (7) must be more effective than (1) and (3).

If current bond-strength values are taken for C—H and S—H links, then (5) and (7) should be exothermic and (6) decidedly endothermic, whereas (1) and (3) should be nearly thermoneutral, though it is possible to explain the exothermicity of reactions (1), (3) and (6) by ascribing large resonance stabilization to the *R*—CO· free radical. The resonance concept does not, however, account for the greater ease of occurrence of the chain (5–7), and, as our Dutch colleagues have pointed out[4], it would seem that in our reaction, too, the activation energy required for attaining the transition state

$$R_1—S\ .\ .\ .\ .\ H\ .\ .\ .\ .\ CR_3$$

may be less than for the hydrogen transfer between hydrocarbon radicals

$$R'_3C\ .\ .\ .\ .\ H\ .\ .\ .\ .\ CR_3.$$

The scope of this thiol-catalysed decarbonylation of aldehydes is now under investigation, and details will be submitted for publication in the near future. It is also proposed to search for other instances of dehydrogenation by thiyl radicals, $R—S^{\cdot}$, since the tentative speculation made by one of us some years ago[5] that thiol-containing enzymes may act by promoting homolytic dehydrogenation may now prove to be capable of exemplification with simpler organic molecules.

E. F. P. Harris
W. A. Waters

Dyson Perrins Laboratory,
Oxford.
Jan. 21.

[1] See Steacie, E. W. R., "Atomic and Free Radical Reactions" (1946).
[2] *J. Amer. Chem. Soc.*, **69**, 2917 (1947).
[3] *J. Org. Chem.*, **14**, 248 (1949).
[4] See preceding communication.
[5] Waters, "The Chemistry of Free Radicals", 257, 283 (1946).

Mechanism of the Reaction between Dichromate and Diphenylcarbazide

The colour reaction between dichromate and diphenylcarbazide in acid medium is the basis of the best method yet devised for the detection and colorimetric estimation of small amounts of chromium. According to Cazeneuve[1], the intense colour is undoubtedly due to an organo-metallic chromium complex. Attempts were made by Moulin[2] to isolate the compound but without any success. Thus the mechanism of the reaction has remained unknown.

$$2\,Cr^{+6} + 3\,CO\langle^{NH—NHC_6H_5}_{NH—NHC_6H_5} \text{ (diphenyl-carbazide)} \rightleftharpoons 2\,[Cr^{+3}\text{-carbazone}^{-2}]_{\text{complex}} + CO\langle^{N=NC_6H_5}_{N=NC_6H_5} + 4H^{+}$$
(diphenyl-carbodiazone)

$$Cr^{+6} + 3\,CO\langle^{N=NC_6H_5}_{NH—NHC_6H_5} \text{ (diphenyl-carbazone)} \rightleftharpoons [Cr^{+3}\text{-carbazone}^{-2}] + 2 \text{ diphenyl-carbodiazone} + 2H^{+}$$

$$Cr^{+3} + CO\langle^{N=NC_6H_5}_{NH—NHC_6H_5} \rightleftharpoons [Cr^{+3}\text{-carbazone}^{-2}] + 2H^{+}, \text{ where carbazone}^{-2} = C\langle^{N=NC_6H_5}_{O^{-}\quad\quad -}\rangle N—N—C_6H_5$$
(diphenyl-carbazone)

In the present work, attempts have been made to elucidate the mechanism of the reaction from different physico-chemical points of view. It has been noted that, for the reaction to occur, the chromium must be in the hexavalent state. This leads to the conclusion that it must be a redox reaction, and possibly also coupled with complex formation. Chromium in the tervalent state fails to react with either diphenylcarbazide or its oxidation product diphenylcarbazone, but hexavalent chromium reacts with both, producing the same colour reaction. However, chromium in the bivalent state reacts with diphenylcarbazone to produce the same colour reaction, but fails to react with freshly prepared carbazide which is free from carbazone. Excess of chromous ion or excess of dichromate ion destroys the colour, probably owing to the reduction of carbazone to the carbazide in the first case and oxidation of the carbazide to its higher oxidation product carbadiazine, or even further, in the latter case. The spectral curves of three different systems, namely, chromate–carbazide, chromate–carbazone and chromous–carbazone are found to be identical, having an absorption maximum at 540 mμ.

A quantitative study of the reaction from spectrophotometric measurements was made by the method of Job[3]. For mixtures of chromate–carbazide and working with equimolecular solutions, the maximum reaction was found to correspond to a ratio of chromate to carbazide of 2 : 3. For the chromate–carbazone reaction this ratio was 1 : 3 and for chromous–carbazone mixtures it was found to be 1 : 1.

These observations can be explained by the accompanying reactions.

Transport measurements on concentrated solutions of mixtures of chromate and carbazide showed the compound to be of a non-electrolytic type. This is also in conformity with the above formulation of the compound as an inner metallic chromium complex.

That the compound formed contains chromium in the bivalent state is corroborated by magnetochemical methods. Magnetic susceptibility measurements were made with solutions of chromate–carbazide mixtures in which the ratio of chromate to carbazide was 2 : 3 (corresponding to the maximum composition in Job's method, where as a first approximation it can be considered that the complete conversion of chromate to the chromous complex has occurred). The solution was found to be paramagnetic, and calculation gave a susceptibility of 4·5 Bohr magnetrons for the moment of chromium, which is undoubtedly due to bivalent chromium.

Details of the mechanism of the reaction and its kinetics will be published elsewhere.

My thanks are due to Prof. P. B. Sarkar for his interest and kind encouragement, and to Dr. B. C. Haldar for his helpful suggestions during the progress of the work.

Monisha Bose
Department of Physical Chemistry,
University College of Science and Technology,
Calcutta 9.
Jan. 21.

[1] Cazeneuve, P., *C.R. Acad. Sci., Paris*, **131**, 346, 347 (1900).
[2] Moulin, A., *Bull. Soc. Chem.*, **31**, 295 (1904).
[3] Job, P., *C.R. Acad. Sci., Paris*, **180**, 928 (1925).

FORTHCOMING EVENTS

Wednesday, August 6—Friday, August 8

FARADAY SOCIETY (in the Department of Zoology, The University, Cambridge).—General Discussion on "The Physical Chemistry of Proteins".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned :

ASSISTANT STATISTICIAN (preferably holding a degree in economics with statistics) in the Department of the Commercial Manager—The Secretary, East Midlands Gas Board, Beverley House, University Street, Leicester (August 12).

STATISTICIANS in the Department of Census and Statistics, Ceylon —The Office of the High Commissioner for Ceylon in London, 13 Hyde Park Gardens, London, W.2 (August 13).

LECTURER IN AGRICULTURAL CHEMISTRY (with an honours degree, or its equivalent, and considerable general experience with special experience in animal nutrition)—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (August 16).

RESEARCH DEMONSTRATOR IN MATHEMATICS—The Registrar, The University, Sheffield (August 16).

ASSISTANT WATER ENGINEER—The Managing Director and Engineer, Lowestoft Water and Gas Company, 163 High Street, Lowestoft (August 20).

RESEARCH ASSISTANT IN PSYCHOLOGY—The Secretary, The University, 38 North Bailey, Durham (August 20).

LECTURER, Grade II (graduate, with a first-class certificate of competency under the Coal Mines Act) IN MINING (Coal), and a LECTURER, Grade II (with a good honours degree, and practical experience in coal preparation) IN COAL TREATMENT—The Secretary, The University, Birmingham 3 (August 23).

RESEARCH ASSISTANTS for work with a small team engaged in research, IN THE DEPARTMENT OF MINING, on the chemical constitution of coal, and a RESEARCH FELLOW IN COAL TREATMENT—The Secretary, The University, Birmingham 3 (August 23).

RESEARCH OFFICER IN THE PLANT AND SOILS LABORATORY, Brisbane, for research on the nutrient requirements of subtropical plants with special reference to pasture legumes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Ref. No. 3922 (August 23).

ZOOLOGIST (with a first- or second-class honours degree in zoology) for research on the ecology of streams, rivers or lakes—The Director, Freshwater Biological Association, The Ferry House, Far Sawrey, Ambleside, Westmorland (August 31).

ASSISTANT LECTURER IN PHYSICAL CHEMISTRY—The Secretary, University College, Earlsfort Terrace, Dublin (September 1).

BIOCHEMIST (with research experience) to work on problems connected with tissue metabolism and the metabolism of cancer-producing substances—The Secretary, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3 (September 1).

DIRECTOR OF THE IMPERIAL INSTITUTE—The Secretary, Ministry of Education (Establishments General), Curzon Street, London, W.1 (September 1).

ASSISTANT TEACHER (Grade B) IN ZOOLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (September 5).

CHEMICAL ENGINEER or CHEMIST, with experience in the design and operation of pilot plants used for obtaining process data, and familiar with instrumentation for automatic control of such plant (Ref. TT/505); a SCIENTIST II—PHYSICIST (with a good honours degree), for laboratory investigations on the briquetting of coal and allied materials (Ref. TT/506); SCIENTIST III—PHYSICISTS and ORGANIC CHEMISTS (with a good honours degree), for laboratory investigations on the briquetting of coal and allied materials (Ref. TT/507); a SCIENTIST III, with University or other recognized training in mineral engineering or coal preparation to second-class honours standard (Ref. TT/508); and SCIENTIFIC TECHNOLOGISTS (Grade I), as mechanical and electrical technologists for design, construction and operation of pilot plant connected with the briquetting of coal (Ref. TT/509): at the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (September 10).

ASSISTANT LECTURER IN ARCHÆOLOGY—The Registrar, University College, Cathays Park, Cardiff (September 13).

CHAIR OF CIVIL ENGINEERING in the University of Western Australia —The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

SENIOR RESEARCH FELLOW IN THE DEPARTMENT OF STATISTICS in the Research School of Social Sciences, Australian National University, Canberra—The Administrative Officer in the U.K., Australian National University, 27 Russell Square, London, W.C.1 (September 15).

PHYSICAL CHEMIST, or ORGANIC CHEMIST with special experience of spectroscopy and electrochemistry, as Research Fellow in the Department of Medical Chemistry in the John Curtin School of Medical Research—The Administrative Officer in the U.K., Australian National University, 27 Russell Square, London, W.C.1 (October 31).

ASSISTANT LECTURER (Grade B) IN METALLURGY—The Principal, North Staffordshire Technical College, Stoke-on-Trent.

BURSARIES (2) IN THE CHEMISTRY DEPARTMENT of the Imperial College of Science and Technology for research on (*a*) the constitution of molten silicates using viscosity techniques, and (*b*) the fundamental aspects of the sorption of hydrogen by iron—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

BURSARIES (2) IN THE NUFFIELD RESEARCH GROUP IN EXTRACTION METALLURGY at the Royal School of Mines, for research on the physical chemistry of high-temperature equilibria involving (*a*) molten silicates, and (*b*) molten iron—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

DEMONSTRATOR IN MICRO-BIOLOGY, a DEMONSTRATOR IN AGRICULTURAL CHEMISTRY, and a RESEARCH ASSISTANT IN AGRICULTURAL CHEMISTRY, at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

DIRECTOR OF THE BRITISH NON-FERROUS METALS FEDERATION—Peat, Marwick, Mitchell and Co., Lombard House, Great Charles Street, Birmingham 3, endorsed 'Federation Selection Committee'.

EMPIRE RHEUMATISM COUNCIL FELLOWSHIPS—The General Secretary, Empire Rheumatism Council, Tavistock House (N), Tavistock Square, London, W.C.1.

LECTURER IN PHYSICS—Prof. W. H. Watson, Head of the Department of Physics, University of Toronto, Toronto, Canada.

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF AERONAUTICAL ENGINEERING—The Secretary and Registrar, The University, Southampton.

RESEARCH ASSISTANT (with a knowledge of electronics and mechanical physics and, preferably, some research experience) for the development and use of borehole gravimeter—The Department of Geodesy and Geophysics, Downing Place, Cambridge.

SCIENTIFIC OFFICER (graduate in chemical engineering or fuel technology; some practical engineering experience is desirable) for research and development work on coal burning equipment for gas turbines—The Assistant Secretary (Ref. A.18), British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

SCIENTIFIC OFFICERS (2, honours graduates in physics or engineering) IN THE PHYSICS DEPARTMENT, for work on problems in the fields of (*a*) heat transfer and (*b*) particle mechanics, which includes the properties and behaviour of dust particles—The Assistant Secretary, British Coal Utilization Research Association (Ref. A.16), Randalls Road, Leatherhead, Surrey.

SOIL SURVEYOR in the Research Division of the Ministry of Agriculture, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting 'Soil Surveyor 423'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Hull Bulletins of Marine Ecology. Vol. 3, No. 21 : Continuous Plankton Records ; Explanation and Methods, 1946–1949. By K. M. Rae. Pp. 135–155+plates 9–16. 6*s*. 6*d*. Vol. 3, No. 22 : Continuous Plankton Records ; The Decapod Larvæ in the North Sea, 1947–1949. By Dr. C. B. Rees. Pp. 157–184+plates 17–19. 5*s*. 6*d*. (Hull : University College, 1952.) [125

British Coal Utilization Research Association. Annual Report, 1951. Pp. 52. (Leatherhead : British Coal Utilization Research Association, 1952.) [125

Moving to Harlow : the Story of the Resettlement of a Factory and its Workers in one of Britain's 'New Towns' based on a Pilot Social Survey. By Roy Lewis. Pp. 28. (Harlow : Sunvic Controls, Ltd., 1952.) [125

One Hundred and Eighteenth Annual Report of the Royal Cornwall Polytechnic Society. Pp. 64. (Camborne : Royal Cornwall Polytechnic Society, 1951.) 5*s*. [125

Cambridge University Educational Film Council. Fifth Report. Pp. 8. (Cambridge : University Engineering Laboratory, 1952.) [125

Other Countries

Ceylon. Part 4 : Education, Science and Art (L). Administration Report of the Acting Director of Fisheries for the Years 1940 to 1950. (Part 2, 1948 to 1950.) By E. R. A. De Zylva. Pp. L. 62. (Colombo : Government Publications Bureau, 1952.) 1.25 rupees ; 25 cents. [125

Annual Report of the Queen Victoria Museum and Art Gallery, 1950–1951. (Ninety-fourth Year.) Pp. 8. (Launceston : Queen Victoria Museum and Art Gallery, 1952.) [125

Sborník I. Mezinárodního Polarografického Sjezdu v Praze (Proceedings of the I. International Polarographic Congress in Prague). Díl (Part) 1. Pp. 866. 678 Kčs. Díl (Part) 2 : Bibliografie polarografických prací od 1922 do 1950 (Polarographic Bibliography from 1922 to 1950). Pp. 196. 180 Kčs. (Praha : Vydalo Přírodovědecké vydavatelství ; London : Collet's Holdings, Ltd., 1951.) 2 vols., £7. [125

East African Industrial Research Board. Ninth Annual Report, 1951. Pp. 10. (Nairobi : Government Printer, 1952.) [125

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 27, No. 8 : A Preliminary Report on the Behavior of the Pacific Sardine (*Sardinops caerulea*) in an Electrical Field. By Tom Groody, Anatole Loukashkin and Norman Grant. Pp. 311–323. (San Francisco : California Academy of Sciences, 1952.) [135

Address Book of Japanese Botanists, 1951. Pp. ii+52+8. (Tokyo : Science Council of Japan, 1951.) 1 dollar. [145

West African Cacao Research Institute. Annual Report, April 1949 to March 1950. Pp. 84. (Tafo : West African Cacao Research Institute ; London : Crown Agents for the Colonies, 1951.) 5*s*. [145

Science Reports of the Tohoku University, Sendai. Second Series (Geology), Vol. 24 : Mesozoic Hexacorals from Japan. By Motoki Eguchi. Pp. 96+10+28 plates. (Tokyo : Maruzen Co., Ltd., 1951.) [145

World Health Organization. Technical Report Series No. 52 : Expert Committee on Cholera : First Report. Pp. 18. (Geneva : World Health Organization ; London : H.M. Stationery Office, 1952.) 1*s*. 3*d*. ; 15 cents ; 0.60 Swiss franc. [195

Tidal Forces in the Sun's Corona due to Planets. By K. P. Meldahl. Part 3, Illustrations. Pp. 20. (Copenhagen : Berlingske Forlag, 1952.) [195